Payload Verification Program Plan

International Space Station Program

SEPTEMBER 20, 2000

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ERU: /s/ Mary C. Nooney 3-30-01

INTERNATIONAL SPACE STATION PROGRAM

PAYLOAD VERIFICATION PROGRAM PLAN

SEPTEMBER 20, 2000

PREFACE

This document establishes the program-level policy for assuring the compatibility of International Space Station (ISS) payloads with respect to each other and with respect to their interfaces with the ISS. It also documents the underlying principles and rationale upon which the policy is based. Detailed compatibility verification procedures and requirements for payload complements at the element-level[1] and the ISS-level are contained in Appendix C.

Element-level and ISS-level payload complement verification shall all be in accordance with this document.

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KEY WORDS

Element-Level Integration
International Space Station
Payload Complement
Payload Integration
Payload Integration Agreement
Payload Operations
Payload Requirements
Verification
ISS- Level Integration

[1] After each payload rack/non-rack/pallet/integrated external payload adapter has been verified to comply with all requirements, it then becomes necessary to verify that the group of payload racks/ non-racks/pallets/integrated external payload adapters (payload complement) that are to be operated together are compatible with each other and that they can share resources appropriately. The next level of integration is thus referred to as element-level integration. It includes analyses of the interaction between payload racks/non-racks in a pressurized module with the module subsystem or between payload pallets/integrated external payload adapters on the truss between the ISS subsystem. Beyond this, there are also some questions that must be satisfied at the ISS-level, such as whether vented contaminants from inside the station will affect truss-attached payloads, whether the vibrations of an attached payload will affect the micro-gravity environment of a pressurized payload, and whether the element-level or ISS-level payload complement is within its power budget.

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INTERNATIONAL SPACE STATION PROGRAM

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LIST OF CHANGES

SEPTEMBER 20, 2000

All changes to paragraphs, tables, and figures in this document are shown below:

SSCBD	ENTRY DATE	CHANGE	PARAGRAPH(S)
003256	2-19-01	REVISION A	ALL

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1.0 INTRODUCTION

1.1 PURPOSE

This document establishes the program-level policy for managing the verification and compatibility assessment analysis of International Space Station (ISS) payloads.

This document includes policies and procedures for compatibility verification of payload complements, both at the element-level and at the ISS-level. These categories of verification shall be in accordance with this document.

1.2 SCOPE

This document applies to all ISS program participants and defines and establishes organizational roles and responsibilities for implementing the verification process for element-level and ISS-level payload integration. It encompasses the verification planning as well as the acquisition, review, approval, closure, and tracking of verification data leading to certification of payload complement compatibility and safety. This document also describes the underlying principles upon which the payload verification program policy is based.

Some of the verification functions described in this document are the responsibility of the payload rack/non-rack/pallet/integrated external payload adapter integrators. Other verification functions are the responsibility of the International Partners (IPs) and the Space Station Program (SSP) Payload Engineering Integration (PEI) team.

The detailed information required for verification of individual payloads, racks, non-racks, /integrated external payload adapters, or pallets is not addressed in this document. That information is provided in the family of Generic Payload Verification Plans (GPVPs). These plans address the unique verification requirements for truss attached payloads/integrated external payload adapters and payloads that are installed in the United States Laboratory (USL), the Japanese Experiment Module – Exposed Facility (JEM-EF), the Centrifuge Accommodation Module (CAM), and the Attached Pressurized Module (APM). The GPVP includes instructions for preparation of verification plans, generic verification requirements, acceptable methods of verifying compliance with each applicable requirement, and associated data submittal requirements. Some of the data, required in the GPVP, is used by the Payload Engineering Integration team to verify that the payloads are compatible with each other and with the ISS systems. Detailed verification requirements pertaining to pressurized module and attached sites payload integration and to ISS-level payload complements are contained in Appendix C of this document.

1.3 PRECEDENCE

Inconsistencies among ISS program payload verification–related documentation shall be resolved by giving precedence in the following top–down order (also see Figure 1.5–1):

A. ISS Concept of Operation and Utilization (COU), Volume 1: Principles, SSP 50011–01 Rev C

B. Station Program Implementation Plan, Volume 4: Payload Engineering Integration

C. ISS Program Payload Verification Program Plan, SSP 57011

D. Generic Payload Verification Plans

E. Unique Payload Verification Plans

1.4 BACKGROUND INFORMATION

Payloads are categorized as pressurized or attached (unpressurized). Integration of pressurized payloads, which are any payloads operated inside the modules, is the responsibility of a third party [e.g. the payload developer or Expedite the Processing of Experiments to Space Station (EXPRESS) Program]. Attached payloads are integrated onto pallets (or porches), which are also the responsibility of a third party. Moreover, after each payload rack/non-rack payload/integrated external payload adapter/pallet has completed verification of all requirements, it then becomes necessary to verify that the group of payload racks/non-rack payloads/integrated external payload adapters/pallets that are to be operated together are compatible with each other and with ISS systems.

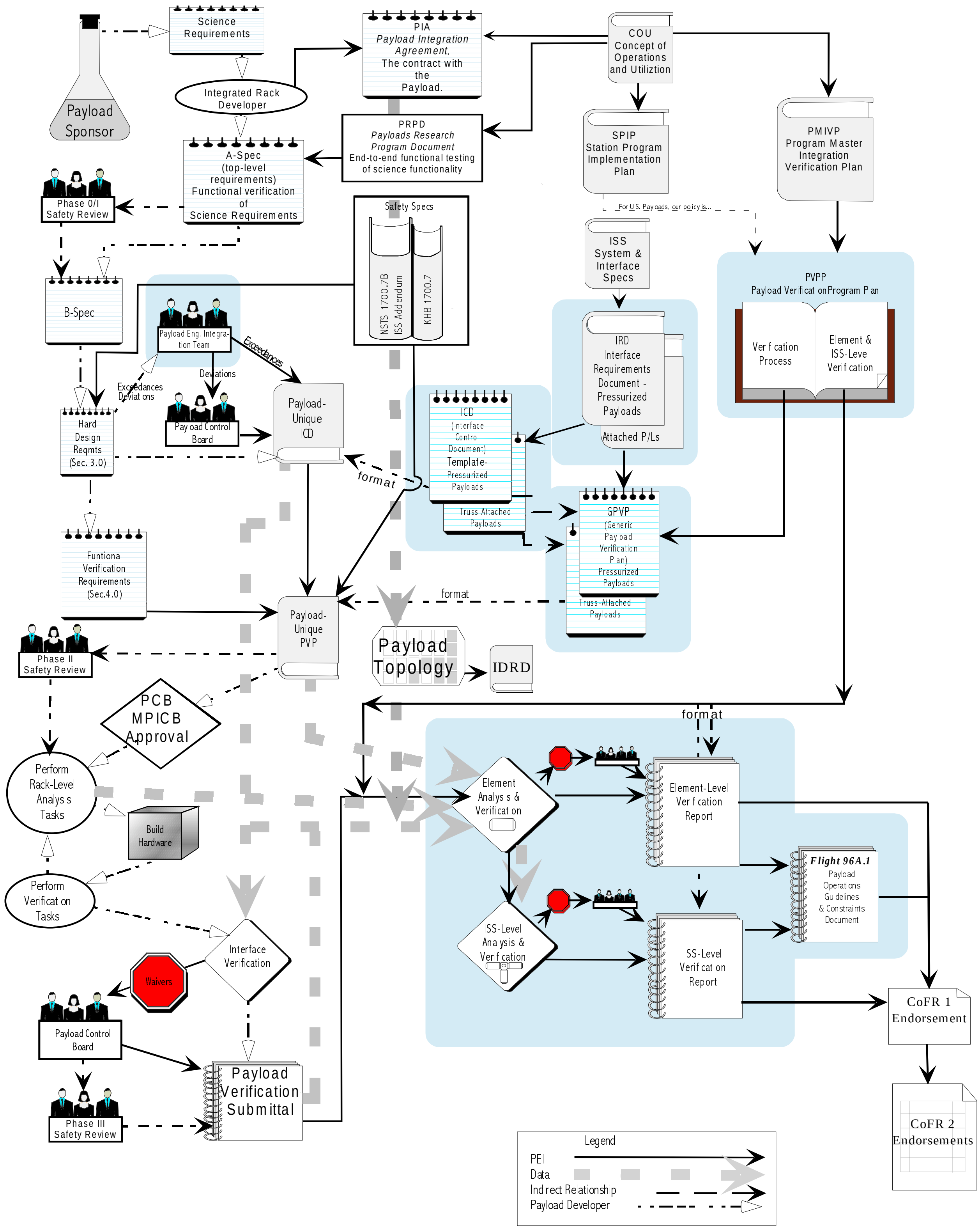
This integration and compatibility verification of pressurized racks/non-rack payloads and unpressurized pallets/integrated external payload adapters into (or onto) pressurized modules or attached sites is handled by the Program. Beyond this, there are also some questions that must be satisfied at the ISS-level, such as whether vented contaminants from inside the ISS will affect truss-attached payloads, whether the vibrations of an attached payload will affect the microgravity environment of a pressurized payload, and whether the ISS-level payload complement is within its power budget. This final compatibility assessment, which relies on inputs from the International Partners, is also the responsibility of the Program.

1.5 PROCESS FLOW

Figure 1.5-1 shows the process flow in combination with the documentation tree for the entire payload integration process, including individual payloads as well as element-level and ISS-level integration and verification. The activities shown on this chart will be the subject of discussion for the remainder of this document. Note that Figure 1.5-1 does not show all of the salient details, but does address the main points of the process.

Figure 1.5-2 summarizes the generic schedule requirements for the Element-Level and ISS-Level complement analysis process.

Figure 1.5-1: Payload Verification: Documentation Tree & Process Flow



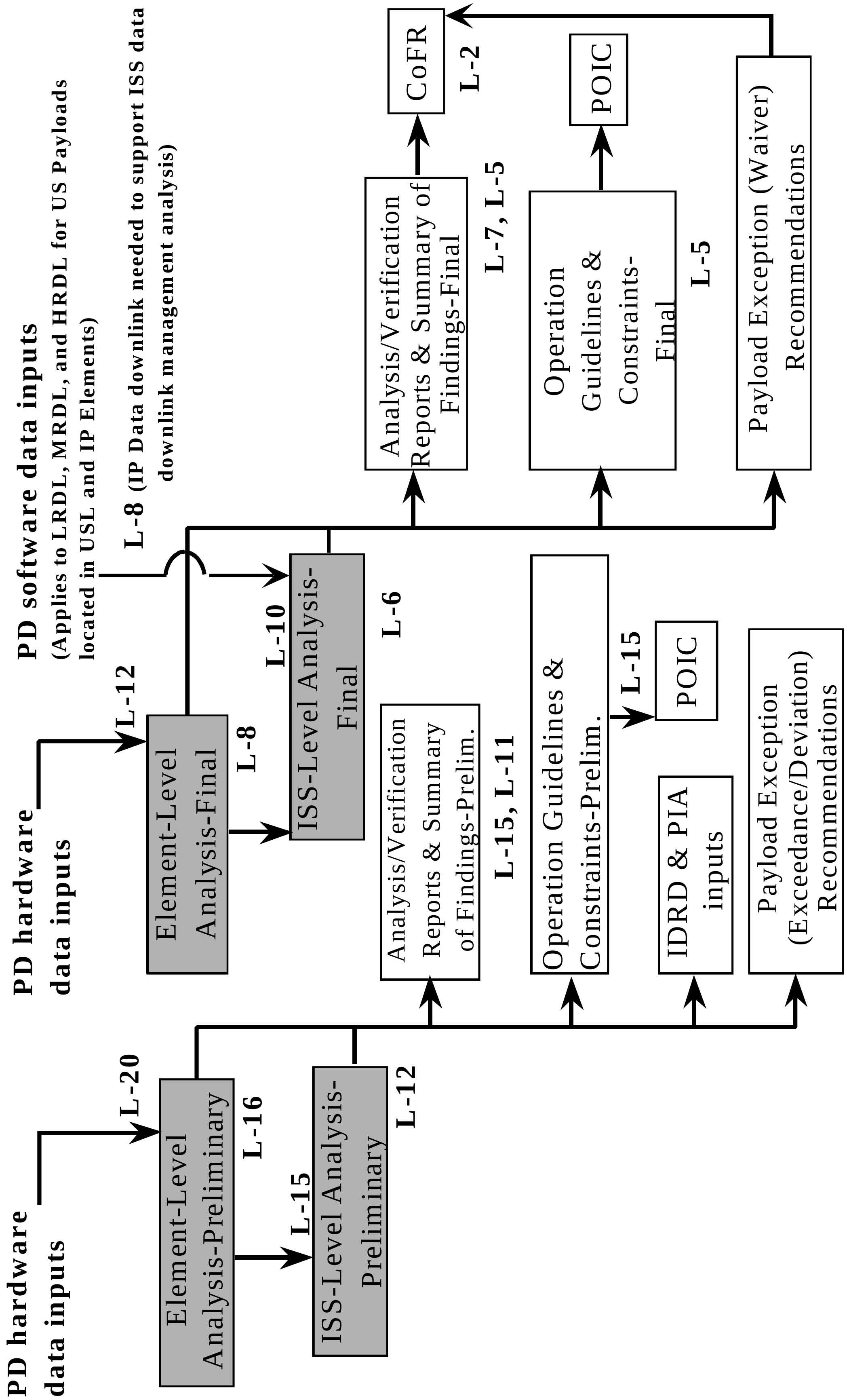


Figure: 1.5-2 COMPLEMENT ANALYSIS PROCESS SCHEDULE

2.0 DOCUMENTATION

2.1 APPLICABLE DOCUMENTS

The following applicable documents include specifications, standards, guidelines, procedures, handbooks, and other special publications. These documents, of the exact issue shown, form a part of these requirements to the extent specified herein. Unless the exact issue and date are identified, the “current issue” cited in the contract Applicable Documents List applies. Inclusion of applicable documents herein does not in any way supersede the contractual order of precedence.

2.1.1 GOVERNMENT DOCUMENTS

D684-10500-03	Command & Data Handling Architecture Description Document, Vol. 3 Software Architecture & Payload Data Link Standards
MIL-HBK-1553	Multiplex Application Handbook
MIL-STD-1553	Digital Time Division Command/Response Multiplex Data Bus
NSTS 1700.7	Safety Policy and Requirements for Payloads Using the Space Transportation System
NSTS 1700.7, ISS Addendum	Safety Policy and Requirements for Payloads Using the International Space Station
Policy 1450-02	Policy and Procedures for ISSP Acronyms/Abbreviations
SSP 30237	Space Station Requirements For Electromagnetic Emission and Susceptibility Requirements
SSP 30238	Space Station Electromagnetic Techniques
SSP 30482	Electrical Power Specifications and Standards
SSP 41000	System Specification for the International Space Station
SSP 41002	International Standard Payload Rack to NASA/ESA/NASDA Modules Interface Control Document
SSP 50005	International Space Station Flight Crew Integration Standard (NASA–STD–3000/T)

SSP 50011–01	Concept of Operation and Utilization, Volume 1: Principles
SSP 50036	Microgravity Control Plan
SSP 50108	Certification of Flight Readiness Process Document (International Space Station Program)
SSP 50200 Vol. 4	Station Program Implementation Plan, Vol. 4 Payload Integration
SSP 52054	Payload CoFR Plan
SSP 52000-PDS	Payload Data Set, Payload Envelope Drawings
SSP 52000-PVP-EPP	EXPRESS Pallet Verification Plan
SSP 52000-PVP-ERP	EXPRESS Rack Verification Plan
SSP 54103	Increment Definition Requirements Document
SSP 57000	Pressurized Payloads Interface Requirements Document
SSP 57003	Attached Payloads Interface Requirements Document
SSP 57010	Pressurized Payloads Generic Payload Verification Plan
SSP 57013	Generic Attached Payloads Verification Plan
SSP 57100 (Series Document)	Unique Payload Integration Agreement
SSP 57200 (Series Document)	Unique Payload Hardware ICD
SSP 57300 (Series Document)	Unique Payload Software ICD
SSP 57400 (Series Document)	Unique Payload Verification Plan
JSC 27337	Portable Computer System

2.2 REFERENCE DOCUMENTS

COL-RIBRE-PL-0144	Columbus Pressurized Payloads Generic Verification Plan
COL-RIBRE-PL-0145	Columbus External Payloads Generic Verification Plan

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3.0 PAYLOAD VERIFICATION

3.1 PAYLOAD VERIFICATION PROGRAM BACKGROUND

The verification program policy established by this document provides for a significant departure from the traditional approach to payload verification used on previous space programs.

Departures from the traditional approach to verification are the result of the International Space Station (ISS) Program objective of streamlining the payload verification process to reduce the overall payload integration cycle time. This objective has resulted in a payload verification program that minimizes ISS program oversight and review of the Payload Developer (PD) verification process and implements a distributed verification concept that enables PDs to verify physical and functional interfaces with the ISS at their development/integration site.

The traditional approach to payload compatibility verification is based on the availability of the complete payload complement for analytical and interactive test verification prior to launch. Space Station payload integration is characterized by continuous operation with frequent revisions to the payload complement, which is incrementally modified by the substitution of new payloads. This prohibits the use of the traditional approach to verification.

The International Partners on the ISS Program share their responsibility for the verification of their respective payloads, integrated payload racks/non-rack payloads/pallets/integrated external payload adapters, and element-level payload complements. This situation is unique to the Space Station Program and must be accounted for in the payload verification program policy.

Moreover, the traditional payload verification role of the launch site must be modified for Space Station payloads to be consistent with the following: (1) late payload manifesting; (2) the fact that payload operating complements[2] will not be available for interactive test verification at the launch site; and (3) the large number of payloads that will be integrated into racks/pallets and verified at these levels of integration prior to shipment to the launch site.

3.2 PAYLOAD VERIFICATION PROGRAM PRINCIPLES

The following principles establish the basis for a verification program that is responsive to the unique aspects of ISS payload integration and operations.

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[2] Please see the glossary for a definition of the term payload complement. The word may refer to different groupings of payloads depending on the context in which it is used.

3.2.1 MINIMIZE ISS PROGRAM OVERSIGHT OF PAYLOAD VERIFICATION PROCESS AND DATA

The ISS Program has defined a methodology for documentation of payload verification that attempts to provide some relief of the burden placed on Payload Developers. With the assistance of the element responsible partner Payload Engineering Integration Team, each PD will develop a payload-unique verification plan that is derived from a Program-provided generic verification plan. Upon approval, the PD project manager will be responsible for ensuring the payload is verified using the approved verification methods and submittal dates. Only data that is required for engineering integration, analysis, verification, or validation will be required for dissemination to the partner's PEI teams. Certifications are acceptable for the remaining verification requirements.

3.2.2 STREAMLINE VERIFICATION PLANNING PROCESS

Standardized verification planning document templates, appropriate for each payload class, can be used to simplify the process of developing a payload-unique verification plan. The PD is not required to use these templates. However, the PD is responsible for creating a payload verification plan that addresses all the requirements levied against them. This should be done in a manner that meets Program integration and verification needs.

3.2.3 IMPLEMENT A DISTRIBUTED VERIFICATION CONCEPT

To the maximum extent practical, interface simulators will be made available at the payload development/integration sites such that PDs and the partners can verify all physical and functional interfaces with the elements that will accommodate them.

3.2.4 ELIMINATE REDUNDANT VERIFICATION

Payload interfaces will not be verified at the launch site: normally all interface verification tasks will be done prior to payload shipment to the launch site. Post–shipment health checks and minimal functional testing can be performed at the launch site at the request of the PD or the partners, with the concurrence of the Kennedy Space Center (KSC) administration.

It is possible that modifications may be made to a payload after the hardware/software has been integrated onto the ISS. This would include situations where a sub-rack or sub-pallet payload or modified Orbital Replacement Unit (ORU) has been changed out in an integrated payload facility, or where a repair/replacement component is installed. If only minor changes (or no changes) are made to the interface parameters, then re-verification may be accomplished by similarity analysis. Re-verification is not required, in most cases, for a change-out in which the old and new items are identical in form, fit and function, and in which the replacement unit has already passed acceptance testing. Re-verification will only be required in cases where a modification is made to the form, fit or function of the hardware and/or has an effect on the safety of the payload/Station/crew.

3.2.5 PERFORM PRE–INCREMENT VERIFICATION OF ON–ORBIT PAYLOAD COMPLEMENTS WITHOUT DEVELOPING DETAILED OPERATING TIMELINES

Verification of the compatibility of on–orbit payload complements, as modified by the addition or deletion of payloads, shall be limited to timeline–independent parameters and to the development of operating constraints and guidelines, without consideration of detailed operating timelines.

Payload compatibility analysis includes both timeline-independent and timeline-related aspects. Timeline-independent parameters include volume and mass. A detailed analysis of the timeline-independent parameters can be done well in advance of the launch date because these analyses are not affected by operating timeline changes.

Timeline-related parameters include microgravity (vibrational) disturbances, acoustic interactions, as well as other parameters.

The total effect of payloads on the ISS and on each other depends on their location relative to each other and upon whether the two payloads are operating at the same time. For example, the heat flow from one rack to another depends upon the temperature of the ambient air and of the racks around it. The electromagnetic interference that one payload creates with respect to another is a second example of how payloads affect each other and the ISS, depending on their position and upon the times at which they operate. Moreover, if there are 25 payloads and any combination of three may be active at the same time, then there are 2300 combinations of three payloads that would have to be analyzed. If there are 5 timeline-dependent parameters that must be checked for each combination, then a total of 11,500 analyses would be required.

It is not practical to do detailed timeline analyses involving these parameters, for three main reasons. First, schedule details may change with little advance notice. Experience with the ISS's Phase I program has shown that flexibility in scheduling and operations is highly desirable. Second, the power and thermal environment of the ISS itself changes on an hourly basis. The payloads will affect and be affected by the ISS environment in a manner that precludes point analyses of specific operating complements at specific times. Third, there is no published mission planning timeline available to the partner PEI Teams. The preliminary draft of each increment's On-orbit Operations Summary (OOS) is published at Increment (I)-12 months, basic OOS at I-6 months, and final OOS at I-1 month. This is a planning product of the Payload Operations Integration Center (POIC) that gives a week-by-week plan for which payloads will be operating. However, the final PEI element-level analysis must be completed at L-8 months, and the ISS-Level analysis must be completed at L-5 months. As a result of all the above facts, it is not practical from a time and cost standpoint to do a detailed time-phased integration analysis of payloads. It is certainly important to know which payloads can operate simultaneously and which cannot, but this information can best be provided to the POIC in the form of an Operations Guidelines and Constraints document, rather than as a detailed timeline analysis.

For the aforementioned reasons, each partner's PEI team will provide the POIC with Operational Guidelines and Constraints which will allow POIC to establish detailed timelines at I-12, I-6, and I-1 months. Each partner's PEI team will provide information about which payloads can and cannot operate simultaneously, and which payloads should and should not operate simultaneously under specific conditions.

3.3 PAYLOAD VERIFICATION PROGRAM OVERVIEW

The overall objective of the payload verification program is twofold. First, it must assure that the individual facility-class payloads have an approved verification plan, and that the payload developers provide documentation to the program of their compliance with requirements. Second, it must assure that the payload compatibility analysis produces results that serve the needs of the ISS program. To serve these purposes, a systematic process has been established that is consistent with the principles discussed in Section 3.2. The process ensures compliance with requirements for integration/operation on orbit in the ISS, and also with launch site processing and payload transportation to and from orbit.

Verification is performed at each discrete level of integration, i.e., individual payload, integrated rack/non-rack/pallet/integrated external payload adapter, element-level, and ISS-level. The requirements to be verified are subject to the unique aspects of the payload design, its interfaces, how it operates, and the level of integration involved.

Verification encompasses establishing the compliance with physical, functional, and environmental interface and safety requirements. The ability of the payload to achieve its science objective is the responsibility of the payload developer and is not included in the verification program covered by this document.

Responsibility for individual payload verification rests with the payload developer, and responsibility for integrated payload verification rests with the organization responsible for each subsequent level of analytical integration. This means that each Partner is responsible for the verification of the payloads that they sponsor, and for verification of the complement of payloads in/on their module. NASA is responsible for ISS-level payload complement verification, using data supplied by the IPs and by other organizations responsible for complement-level payload integration.

Payloads that have a finalized verification plan are expected to be at a level of design maturity such that they are ready for their Critical Design Review (CDR). Furthermore, they will have participated in a Phase 2 safety review, which ensures an acceptable method of eliminating or controlling all identified safety hazards. Knowledge obtained from the Phase 2 safety review can be used in the payload verification plan. Thus the two processes, payload safety verification and payload integration verification, are synergistic.

The Unique PVP contains all the payload integration and payload safety requirements in a single document, and describes the methods that will be used to verify each requirement. At the discretion of the PD, it may also include the functionality requirements. The Unique PVP further specifies what data should be submitted to support the Certificate of Flight Readiness

(CoFR) and integrated payload complement-level analyses. For the European Space Agency (ESA), their payload Flight Acceptance Review (FAR) is equivalent to the NASA CoFR.

The verification process is divided into three major phases: planning, implementation, and certification. These phases apply to each level of integration, although the requirements to be verified differ, and in the case of element-level and ISS-level verification, no formal verification plan is required.

3.3.1 VERIFICATION PLANNING

Verification planning consists of establishing (1) the applicable requirements for the specific payload or integrated-payload level, (2) the method of verification to be employed, and (3) the documentation required and submittal schedules. The family of generic PVPs standardizes and simplifies the planning process by providing a list of all known generic verification requirements for each payload class, the approved method(s) for verifying compliance with each requirement, and the associated data submittal requirements. Converting this standard document into a plan for a specific payload facility, rack, pallet or integrated external payload adapter is achieved by designating the applicability of the requirements listed and the method of verification where a choice is offered. Any unique requirements not covered by the generic list are added to the plan. Unique payload verification plans will be jointly approved by NASA and International Partners, as needed.

3.3.2 VERIFICATION IMPLEMENTATION

Verification implementation includes the performance of all the activities necessary to establish compliance with the requirements, and submittal of the related documentation. The verification activities may include analyses, tests, demonstrations, and inspections. Documentation submittal includes both document preparation and transmittal of the data to the appropriate ISS office. Payload compatibility verification utilizes payload data contained in the Payload Integration Agreement (PIA), unique payload hardware and software Interface Control Documents (ICDs), Payload Data Set submittals, Technical Data Sets [such as those contained in the Payload Data Library (PDL)], and the data submittals required by the Unique Payload Verification Plan.

3.3.3 CERTIFICATION

The certification phase consists of submitting up to three types of data, depending on the Program's need for the data to conduct further verification activities. In situations where the data generated during verification of the requirement is not needed for further analyses, a signed Certificate of Compliance (COC) is sufficient. If the results from the verification activities are needed for further analyses, a Data Certificate, which contains a summary of the analysis and/or test results in addition to certification that the requirement has been met, is used. The third type of data submittal is detailed data, (i.e., a completed analysis or test report). Certification is accomplished at the facility class payload level (i.e., integrated rack/non-rack/pallet/integrated external payload adapter) by the responsible partner PEI team.

3.4 PAYLOAD VERIFICATION FUNCTIONAL ROLES AND RESPONSIBILITIES

Payload Developers are responsible for the development and coordination of their Unique PVPs. NASA PEI is responsible for review, concurrence, and approval of all rack-level/non-rack level or attached payload-level Unique PVPs for NASA payloads and for partner payloads accommodated on/in US elements. Each Partner is responsible for their rack-level payloads/non-rack payloads/integrated external payload adapters on/in their elements. Payload Developers are responsible for working issues and tracking closure of open items and exceptions in PVPs, in processing waivers and deviations to specific interface requirements, and in preparation of data submittals.

3.4.1 PAYLOAD PERFORMANCE

Verification of individual payload compliance with performance specifications is the responsibility of the PD and is not required to be addressed by the ISS program–approved PVP. However, the PD may, at their discretion, create Verification Definition Sheets (VDSs) that address payload unique functionality and include them in the Unique PVP.

3.4.2 PAYLOAD INTERFACE COMPATIBILITY AND SAFETY

Verification of payload interface compliance and constraints must comply with the Attached and Pressurized Payload Interface Requirements Documents (IRDs). Safety requirements for on-orbit operations are the responsibility of the PD in accordance with the NSTS 1700.7 ISS Addendum. VDSs may be included in the Unique PVP that show how these safety requirements will be verified.

3.4.3 ANALYTICAL INTEGRATION OF PAYLOAD RACKS/PALLETS

The organization responsible for the analytical integration of a payload rack, non-rack payload, attached payload, attached pallet or integrated external payload adapter shall also be responsible for establishing the applicable verification requirements and for performing all required analytical verification tasks associated with that entity.

3.4.4 PAYLOAD PHYSICAL INTEGRATION

The organization responsible for the ground physical integration of a payload rack, non-rack payload, attached payload, pallet or integrated external payload adapter onto or into the launch vehicle is also responsible for performing whatever tests, demonstrations, or inspections may be required by the ground physical integrator.

3.4.5 VERIFICATION OF REPLACEMENT SUB-RACK AND SUB-PALLET PAYLOADS

Facility-class payloads are designed such that sub-rack or sub-pallet payloads can be interchanged while the rack or pallet remains on-orbit. Verification of sub-rack or sub-pallet payloads is the responsibility of the PD, and verification of the new rack or pallet configuration is the responsibility of the rack or pallet integrator. For example, integration verification for the EXPRESS Rack is described in SSP 574## (EXPRESS Payload Verification Plan Series), and integration verification for the EXPRESS Pallet is described in SSP 52000-PVP-EPP. Integration of EXPRESS sub-rack payloads into the EXPRESS Rack is described in SSP 52000-PVP-ERP.

The transport of these integrated racks and pallets to the Station is the responsibility of the partner; thus the partner is responsible for verification of the integration of the transport rack or pallet into the carrier.

3.4.6 VERIFICATION OF RELOCATED PAYLOADS

If payloads are moved from one ISS element to another, verification of the new configuration is the responsibility of the PD and the new hosting element PEI. Verification of compliance with any changes to physical, functional, and environmental interfaces and safety requirements will also be required. However, verification of the integrated on-orbit complement remains the responsibility of the partner PEI team of the new hosting element. If payloads are stored on orbit and integrated into a payload facility at a later date, the verification of the newly-configured rack, containing the previously stored payloads, is the responsibility of the payload developer. The payload developer is required to submit data to the element-level analytical integrator regarding the interfaces and resource needs of the new rack/non-rack payload/pallet/integrated external payload adapter configuration.

3.4.7 VERIFICATION OF COMPLIANCE WITH LAUNCH SITE SAFETY REQUIREMENTS

The PD shall be responsible for verifying that their payload and associated PL-provided Ground Support Equipment (GSE) complies with launch site safety requirements as defined in KHB 1700.7.

3.4.8 PAYLOAD LAUNCH-AND-LANDING-COMPLEMENT VERIFICATION

All payload verification data at the rack, non-rack, pallet, or external payload adapter, that are necessary to show compliance with element-level launch and landing requirements, shall be collected by the ISS Cargo Integration Organization. These data will be assessed to ensure that the payload complement does not pose any undue safety hazard during transportation to and from the ISS.

3.4.9 VERIFICATION OF NASA MANAGED PAYLOADS IN OR ON INTERNATIONAL PARTNER MODULES/FACILITIES

US managed payload racks/non-rack payloads/integrated or external payload adapters that are integrated into/onto partner modules will be subject to the requirements of the appropriate IRD, Software and Hardware ICDs, and the GPVP. For example, US managed attached payloads that are integrated onto the JEM-EF will be required to satisfy the verification requirements of the JEM-EF. This process is illustrated in Figure 3.4.9-1. Greater detail on the JEM, JEM-EF, and APM is provided in the following paragraphs.

3.4.9.1 JEM

The SSP 57000 series documents (IRD, Hardware and Software ICDs, and the GPVP) capture the interface requirements of the ISPR ICD and JEM pressurized module standard ICD to be used by US payloads. US Rack Integrators will do the rack-level analysis and will provide the applicable data to NASA PEI. NASA PEI will provide the National Space Development Agency of Japan (NASDA) with the required rack-level analysis data that is needed for the JEM element-level analysis. NASDA will perform the element-level analysis for the JEM and will provide the applicable data to NASA PEI for ISS-level analysis.

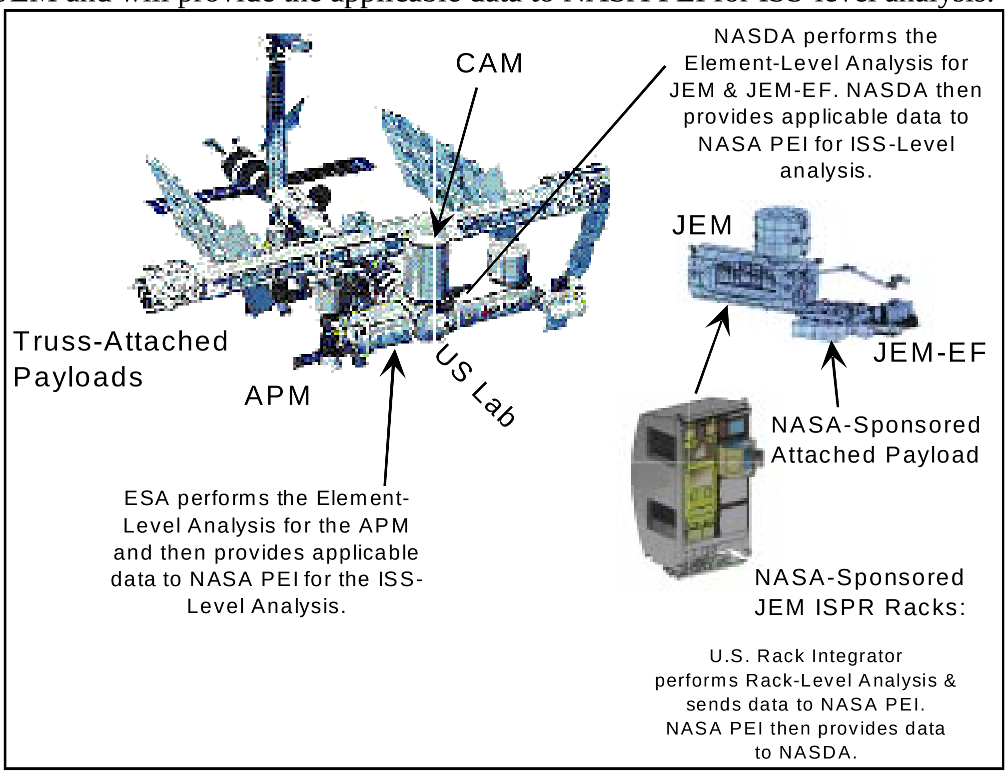

Figure 3.4.9-1: Overview of ISS Payload Complement Verification Tasks

3.4.9.2 JEM-EF

The JEM-EF has unique interfaces that will be captured in the TBD-4. NASDA performs the element-level analysis for JEM-EF. NASDA then provides the applicable data to NASA PEI for the ISS-level analysis.

3.4.9.3 APM

The SSP 57000 series documents (IRD, Hardware and Software ICDs, and the GPVP) capture the interface requirements of the ISPR ICD in USL and CAM and APM implementation of the interfaces to be used by the US payloads. The COL-RIBRE series of documents (IRDs, Hardware and Software ICDs, and GPVPs) capture the interface requirements of the ISPR ICD and additional interface requirements specific to the APM (including the External Payload Facility (EPF)) and will be used by ESA payloads. (TBR-1)

ESA will perform the element-level analysis for the APM, and will provide the applicable data to NASA PEI for the ISS-level analysis.

3.4.10 VERIFICATION, ON–ORBIT VERIFICATION, AND/OR REVERIFICATION

Payload safety hazard controls are generally verified prior to launch. When the PD has defined any on-orbit payload component or rack subsystem planned activities such as hardware modification, component changeout, or maintenance, reverification requirements will be established and implemented on the ground prior to launch. This verification could include a complete or partial rework of the analyses, tests, or inspections that were originally required to show compliance. However, for those payloads where additional verification needs to be accomplished on-orbit, the verification method shall denote that crew procedures are in place to accomplish the required verification tasks. The crew procedures shall be documented in the flight and payload operation data files.

3.4.11 ELEMENT-LEVEL AND ISS-LEVEL PAYLOAD COMPLEMENT VERIFICATION

Verification of element-level and ISS-level payload complement compatibility shall be done in accordance with the Compatibility Verification Definition Sheets (CVDSs) contained in Appendix C of this document. The verification output required in each CVDS is provided in detail on the individual verification process flow diagrams as shown in Figures 3.4.11-2 through 3.4.11-16. The responsibility for element-level integration for the US On-orbit Segment (USOS) lies with NASA's Payload Engineering Integration group. This group is also responsible for ISS-level verification, using data from the element-level analyses. Partner element-level data will be supplied by all IPs for incorporation into the ISS-level integration, analysis, and verification activities. The JEM, JEM-EF, and APM element integrators will provide subsystem data through the Bilateral Data Exchange Agreement Lists (BDEALs) and payload element data through the PVPP to the NASA PEI group to perform the ISS-level compatibility analysis. Figure 3.4.11-1a illustrates the division of responsibilities.

Figure 3.4.11-1b shows the element-level and ISS-level payload verification process flow. Figures 3.4.11-2 through 3.4.11-16 show the detailed flows for each discipline analysis. Each detailed flow is linked to the individual CVDSs shown in Appendix C. For disciplines in which both element-level and ISS-level analyses are required, both processes are shown in the same figure as well as in Table C.2.1-1. ISS-level payload complement compatibility verification includes some of the same analyses as the element-level verification but is performed to ensure that inter-element (pressurized modules and external payloads) effects are considered.

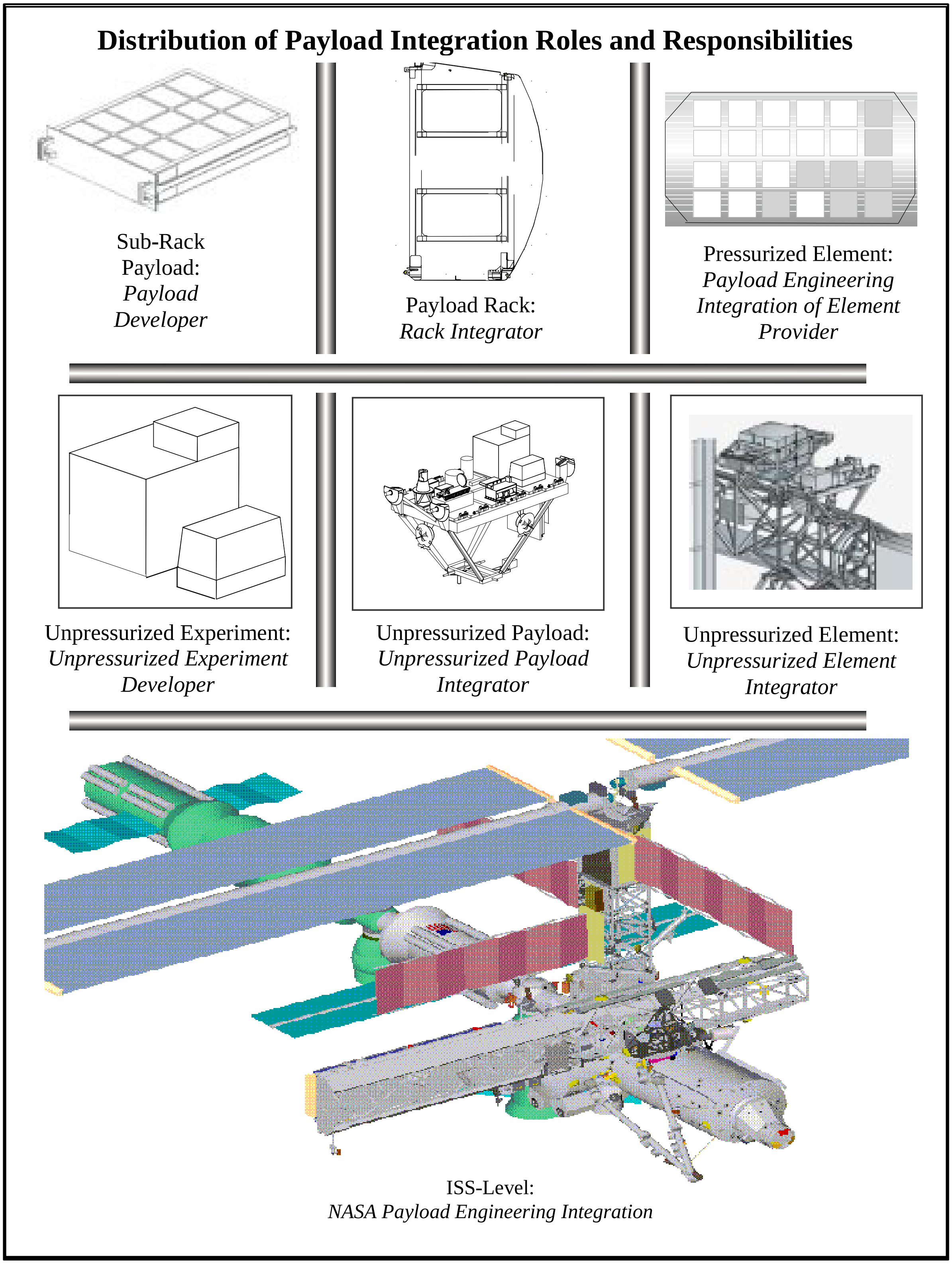

Figure 3.4.11-1a: Distribution of Payload Integration Roles and Responsibilities

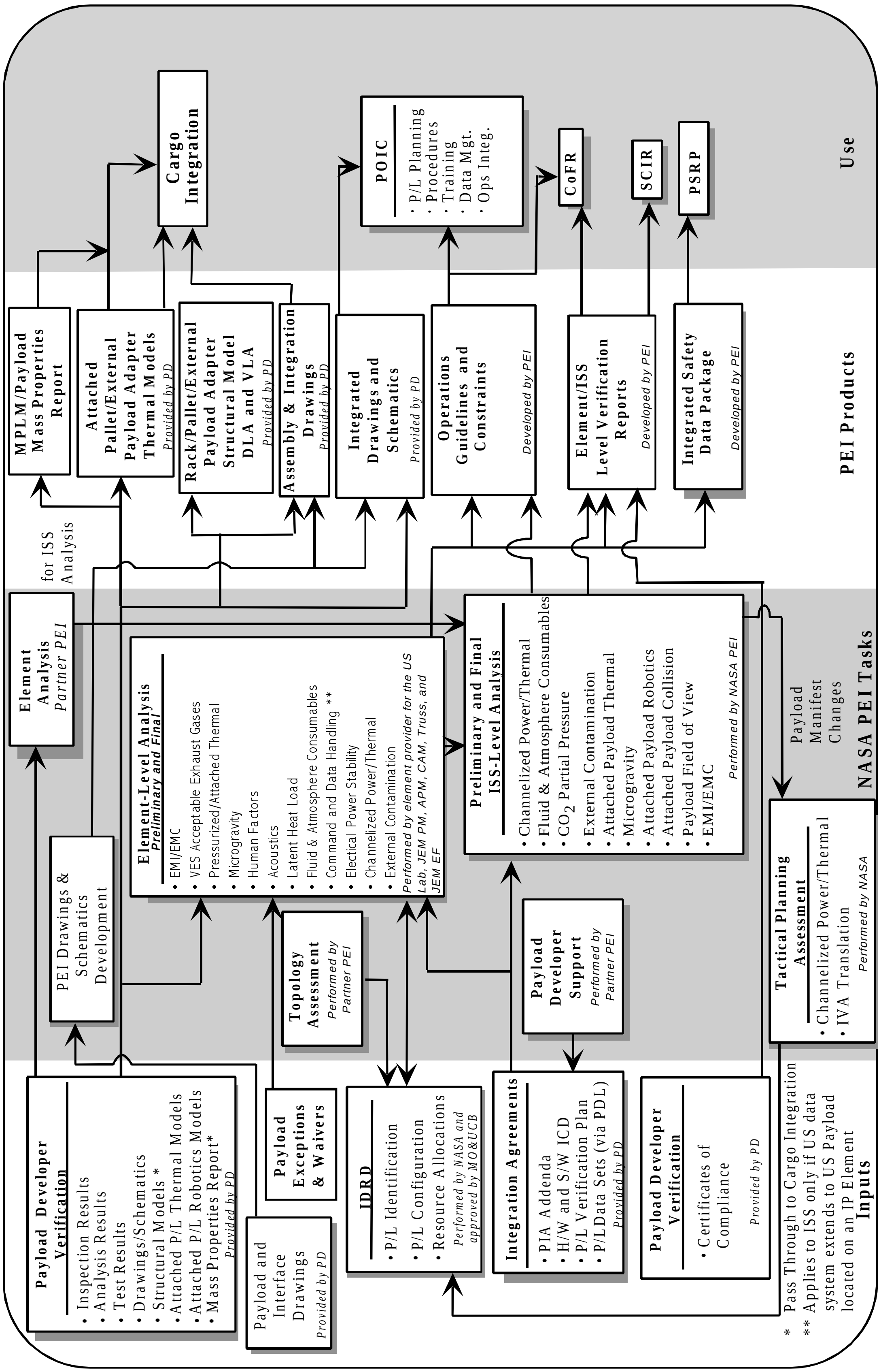

Figure 3.4.11-1b: Payload Engineering Integration Process, Element-Level and ISS-Level

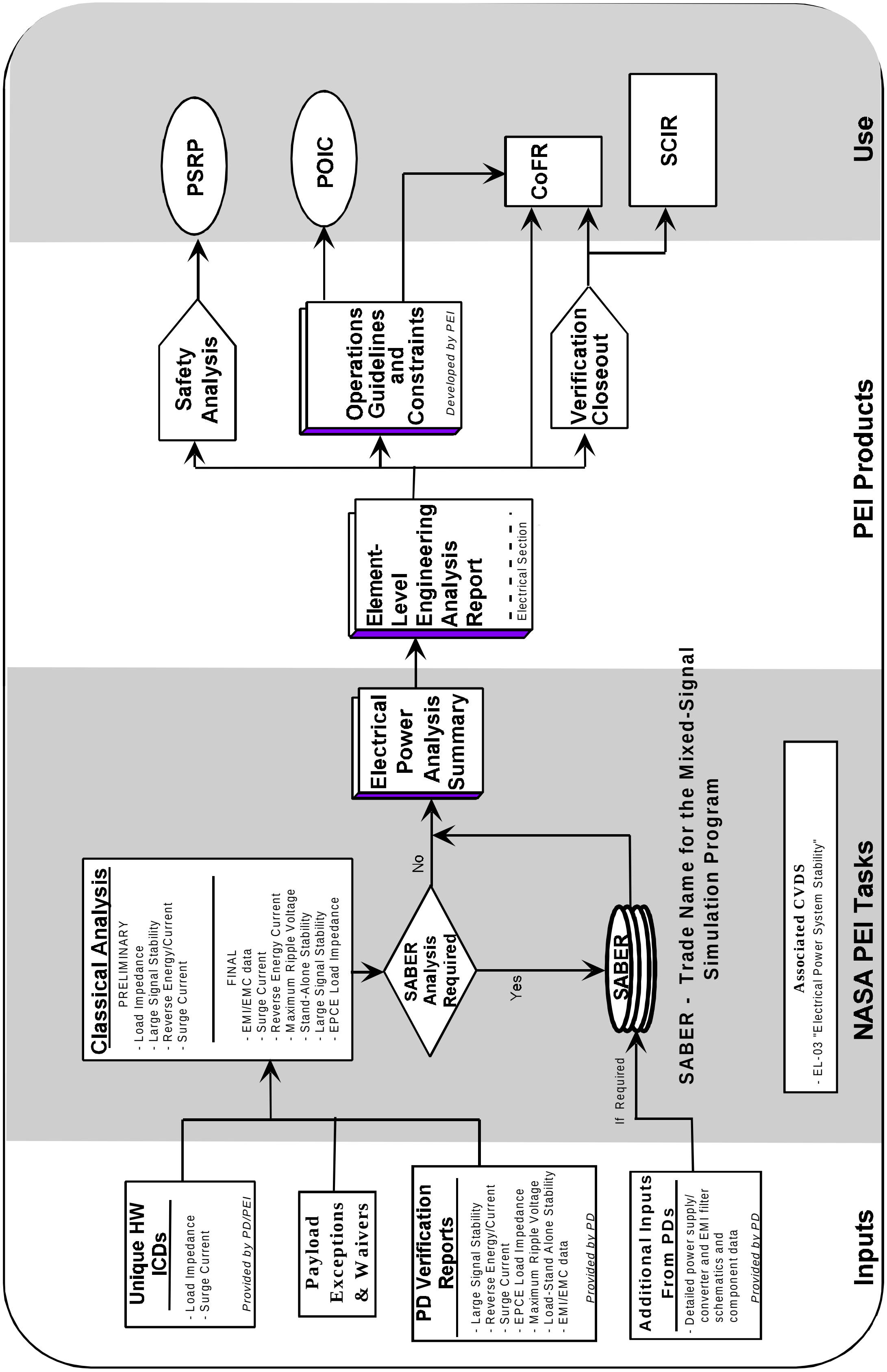

Figure 3.4.11-2: PEI Element-Level Electrical Power Stability Analysis Process

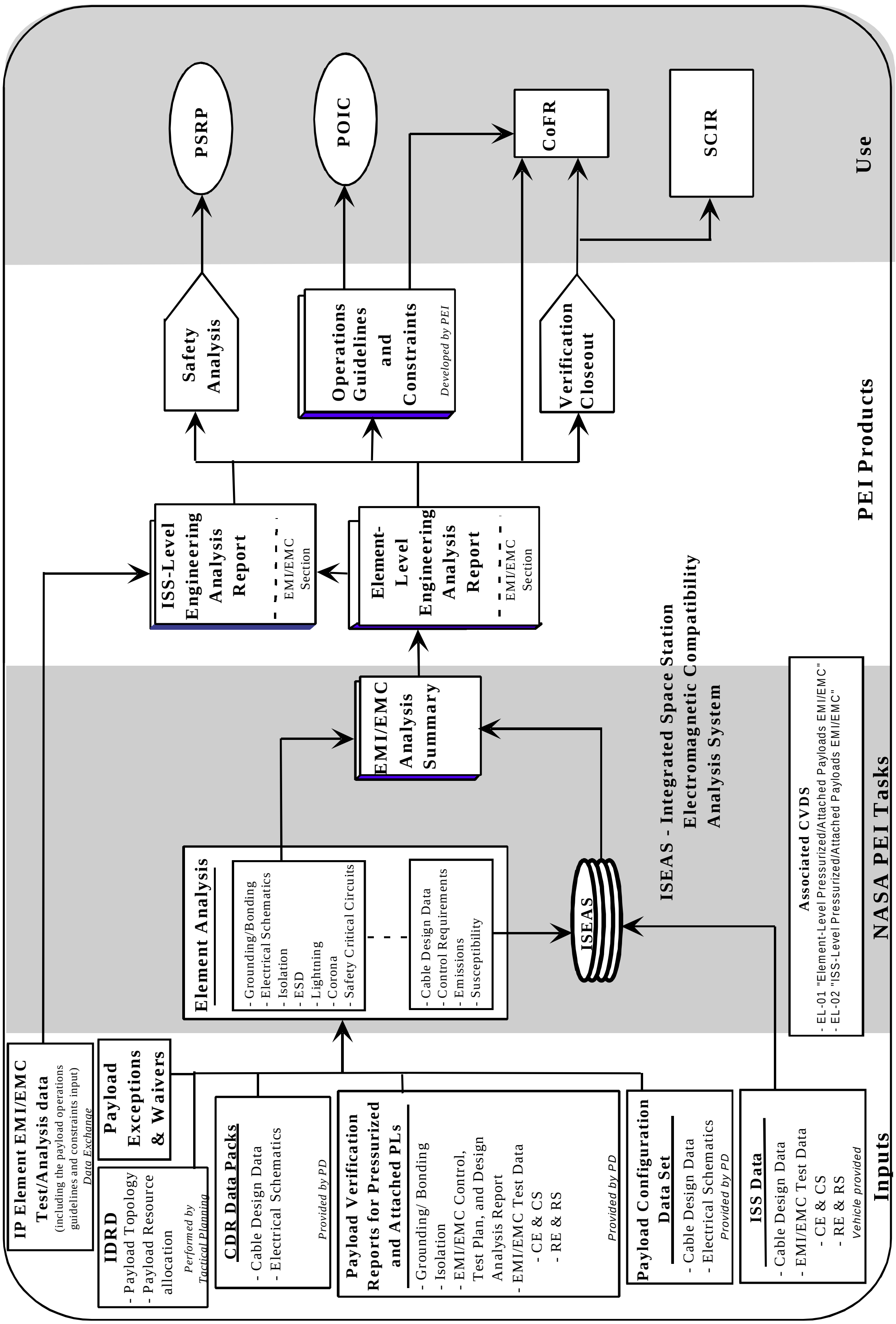

Figure 3.4.11-3: PEI Element-Level and ISS-Level EMI/EMC Analysis Process

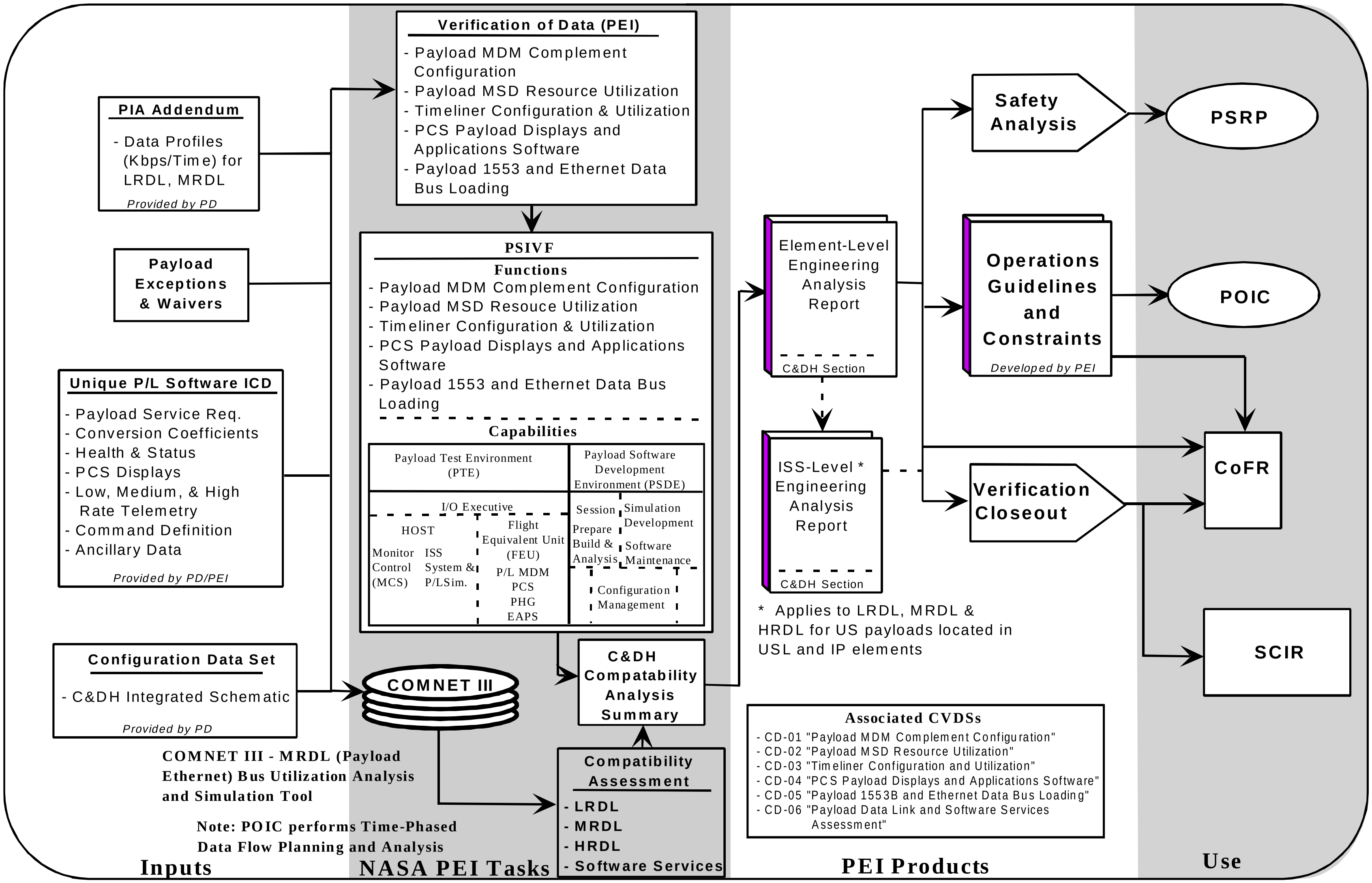

Figure 3.4.11-4: PEI Element-Level and ISS-Level* C&DH Analysis Process for NASA Payloads

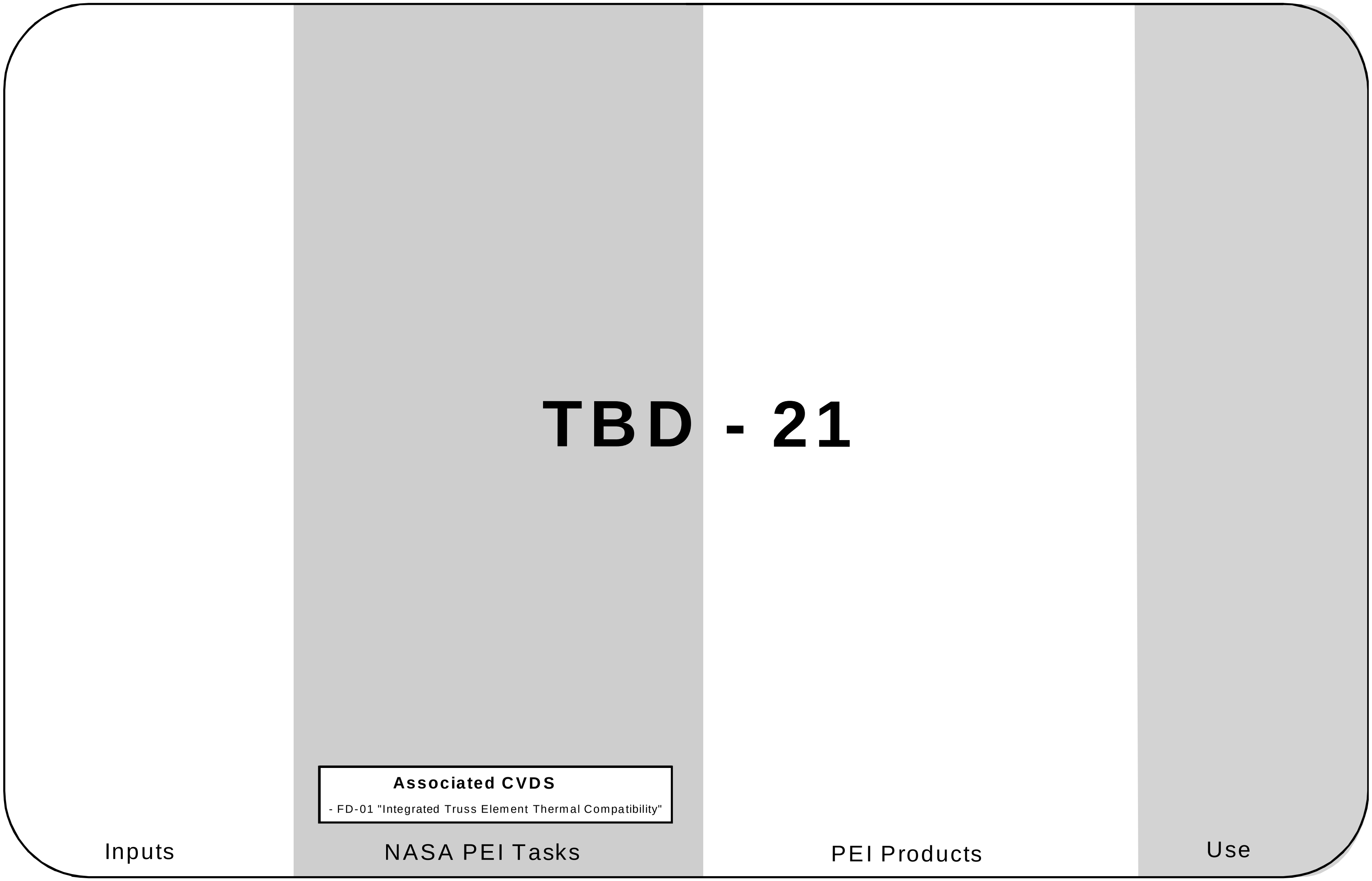

Figure 3.4.11-5: PEI Attached Element-Level Thermal Analysis Process

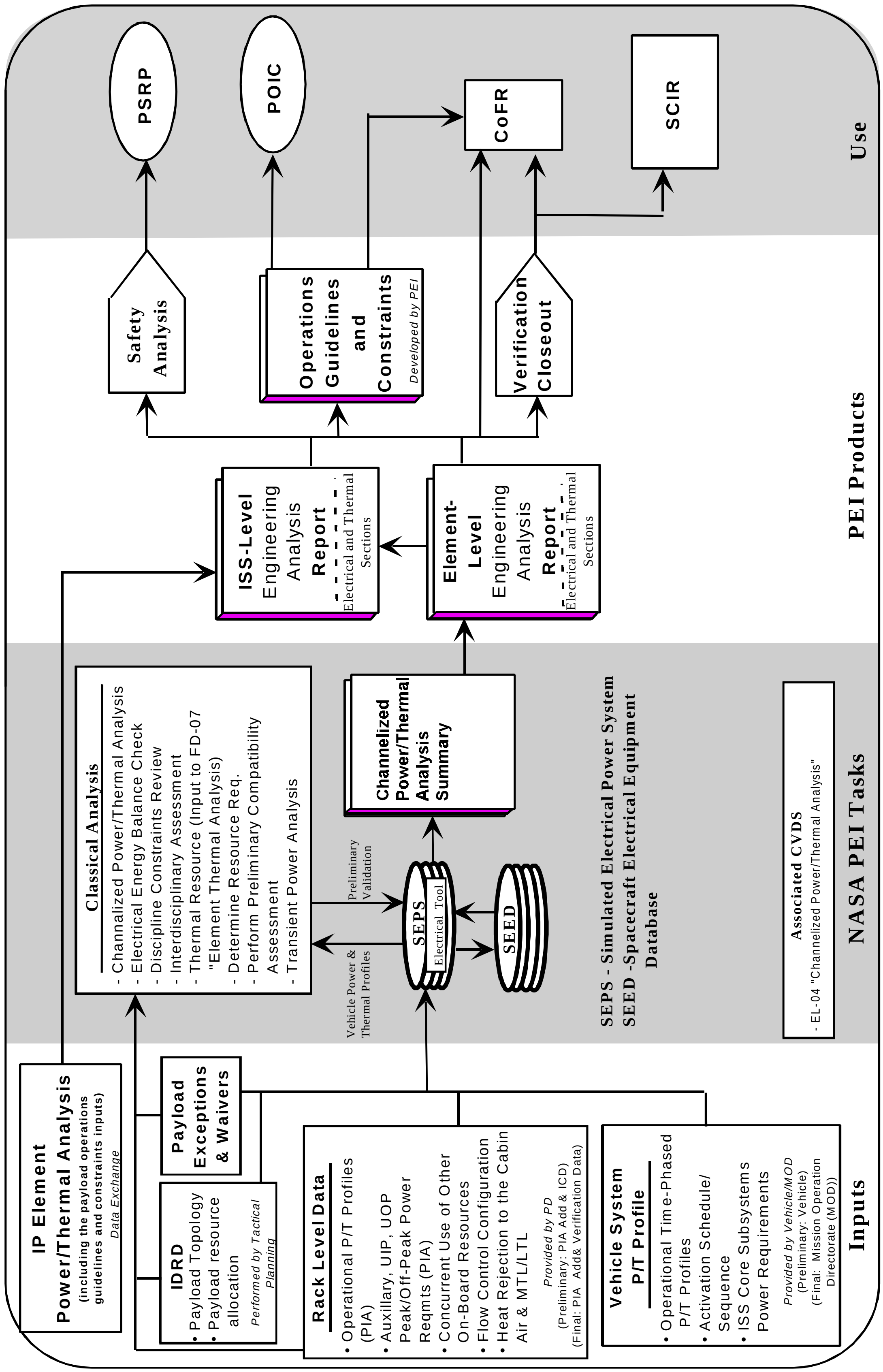

Figure 3.4.11-6 PEI Element-Level and ISS-Level Channelized Power/Thermal Analysis Process

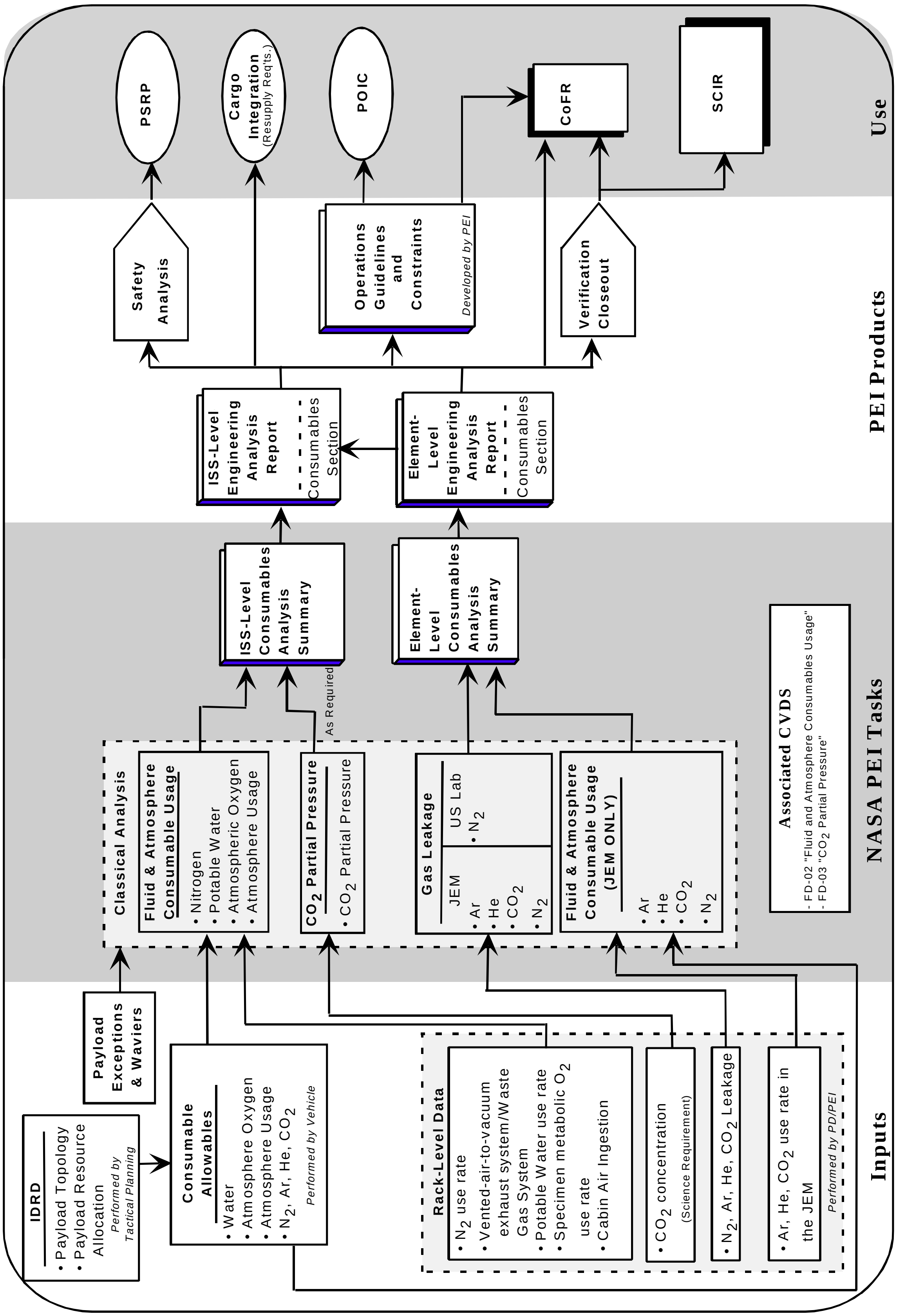

Figure 3.4.11-7: PEI Element-Level and ISS-Level Consumables Analysis Process

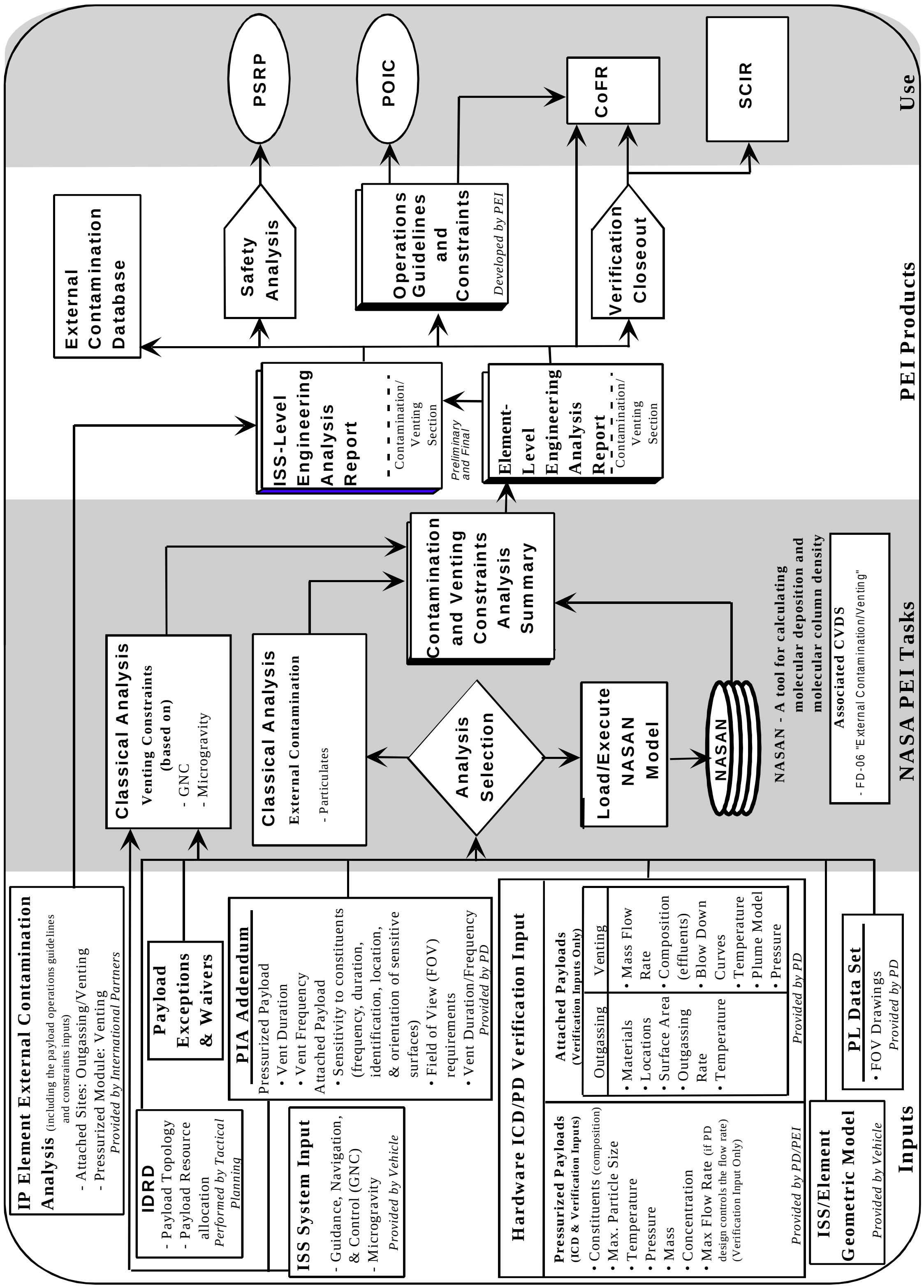

Figure 3.4.11-8: PEI Element-Level and ISS-Level External Contamination/Venting Analysis Process

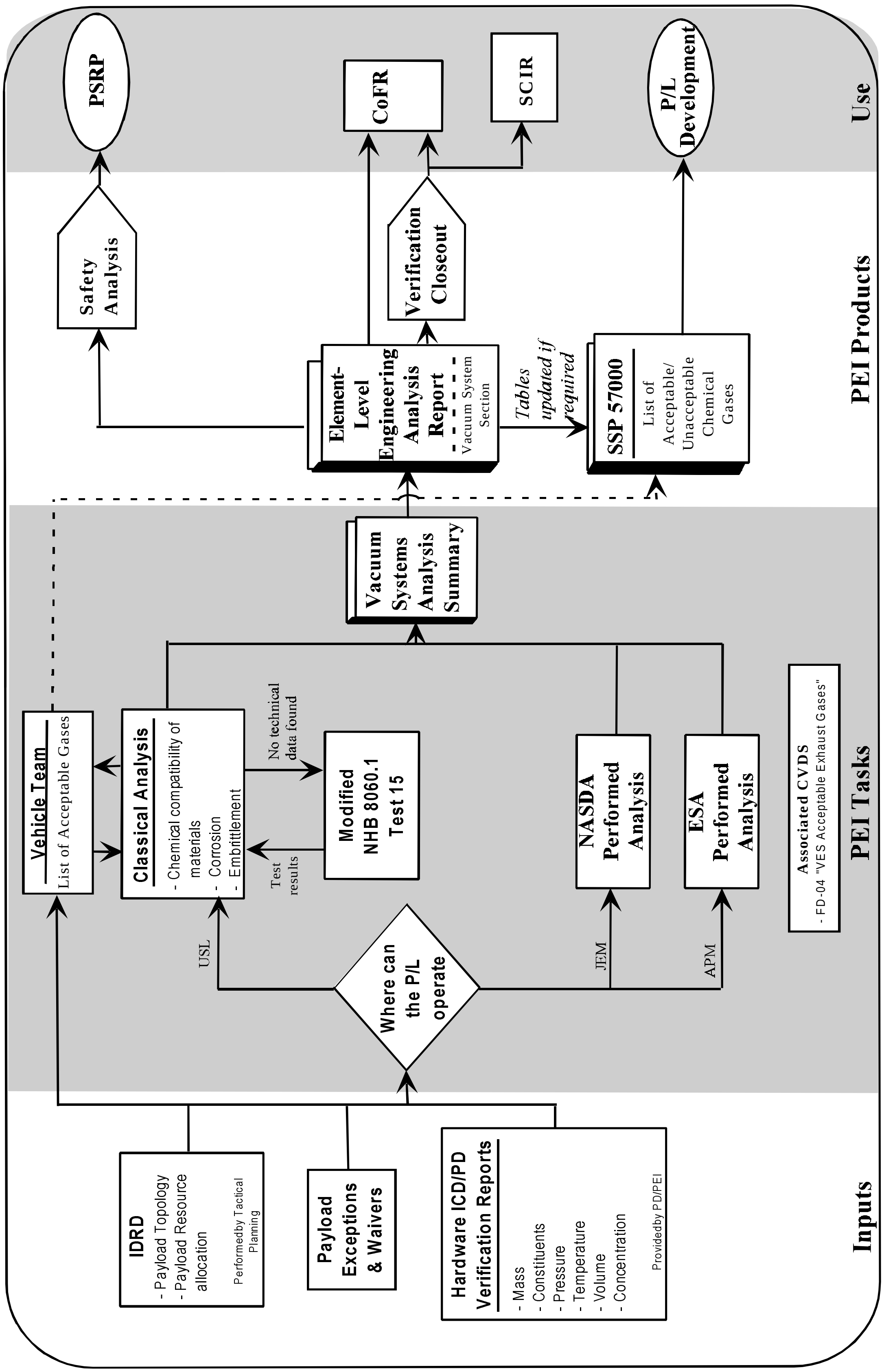

Figure 3.4.11-9: PEI Element-Level Vacuum Systems Wetted Materials Analysis Process

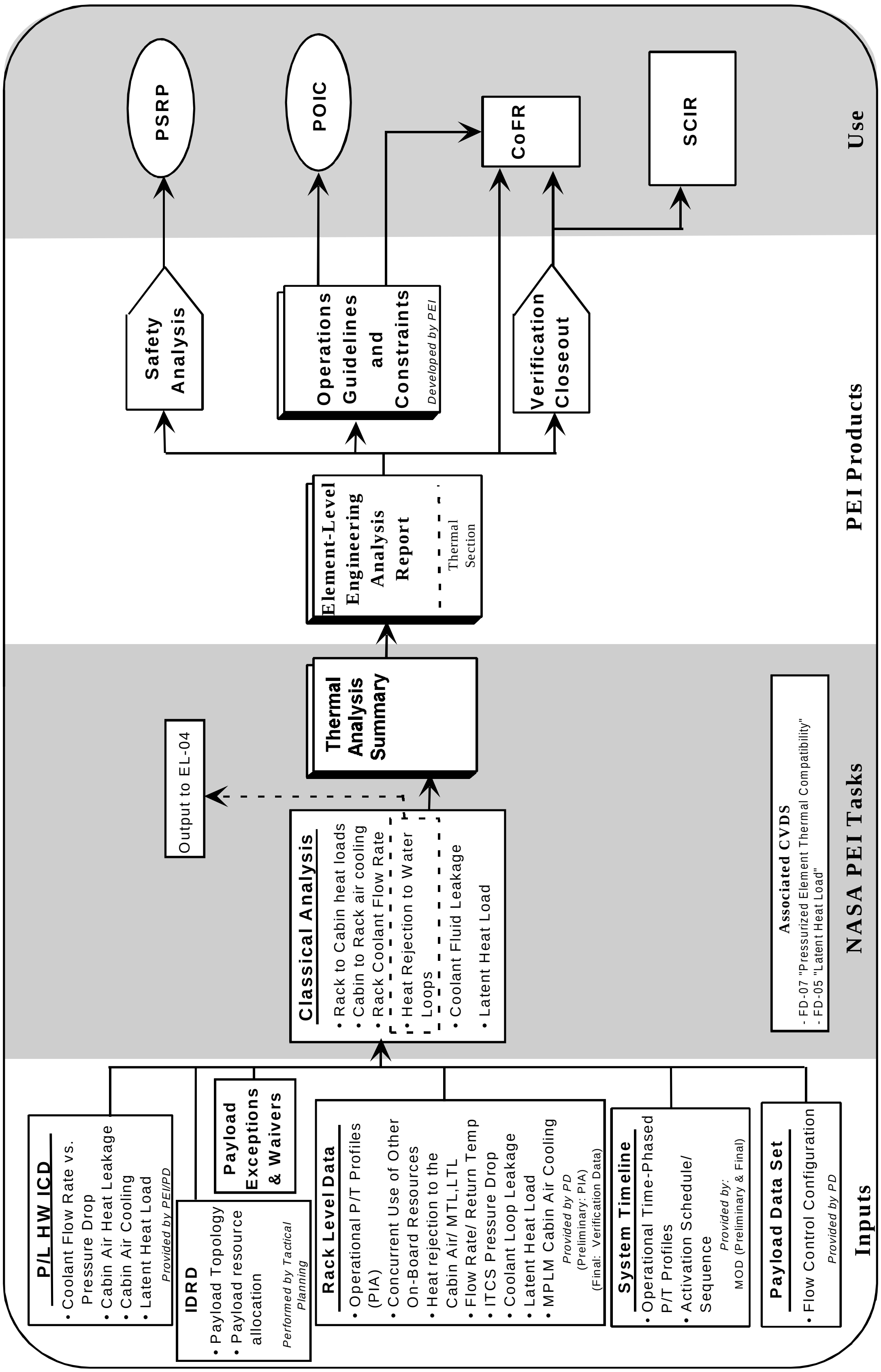

Figure 3.4.11-10 PEI Pressurized Element-Level Thermal Analysis Process

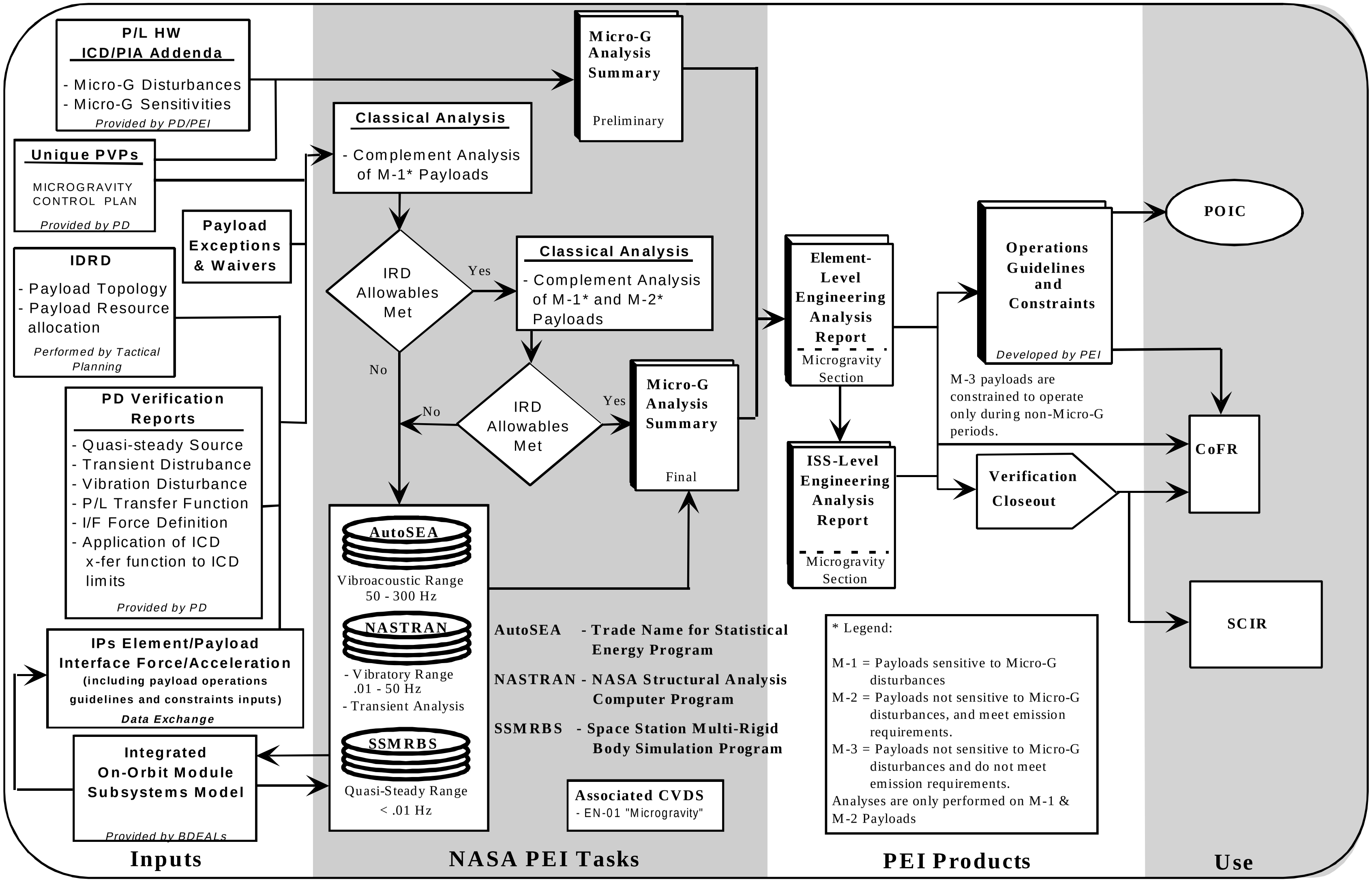

Figure 3.4.11-11: PEI Element-Level and ISS-Level Microgravity Analysis Process

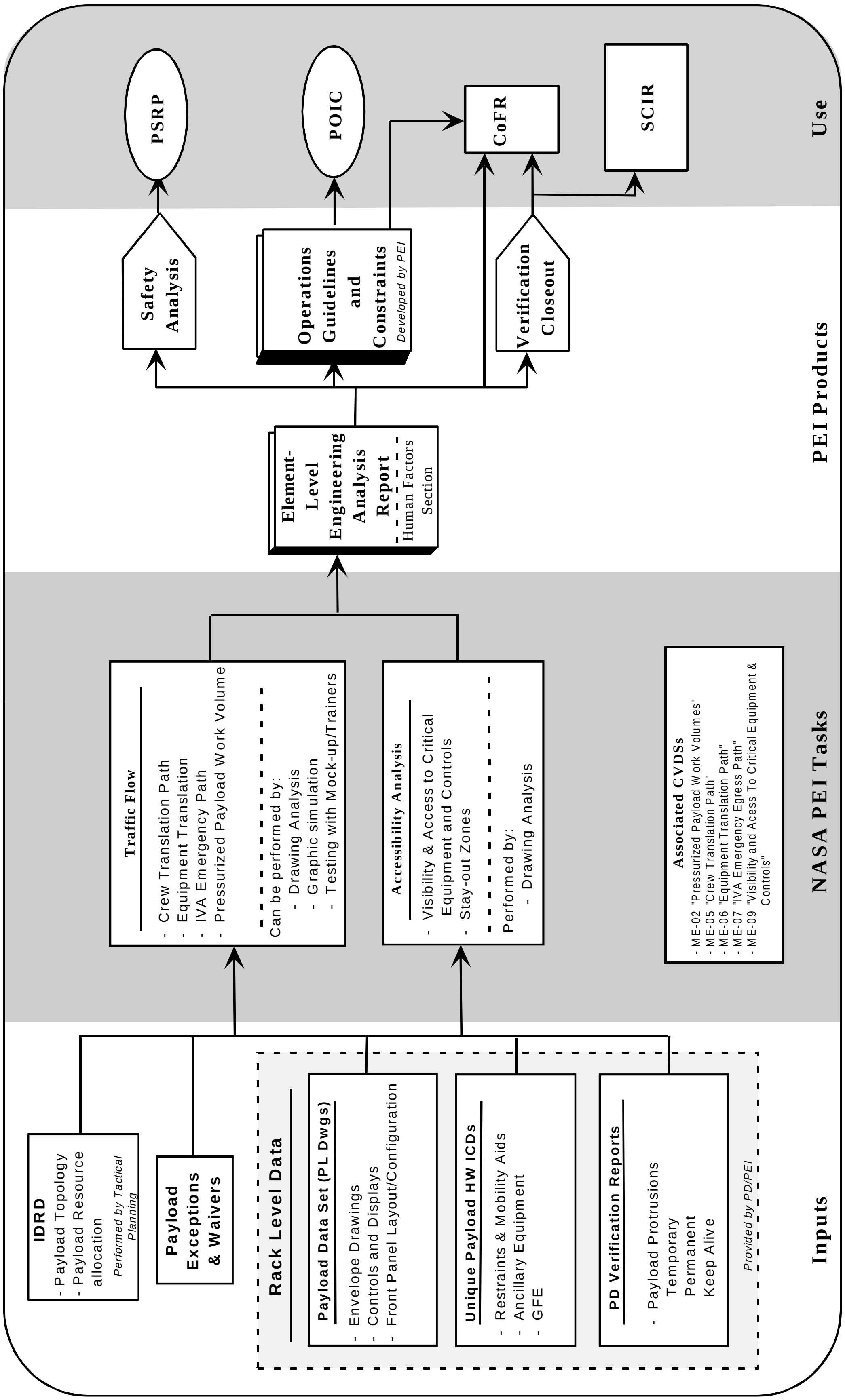

Figure 3.4.11-12: PEI Element-Level Human Factors Analysis Process

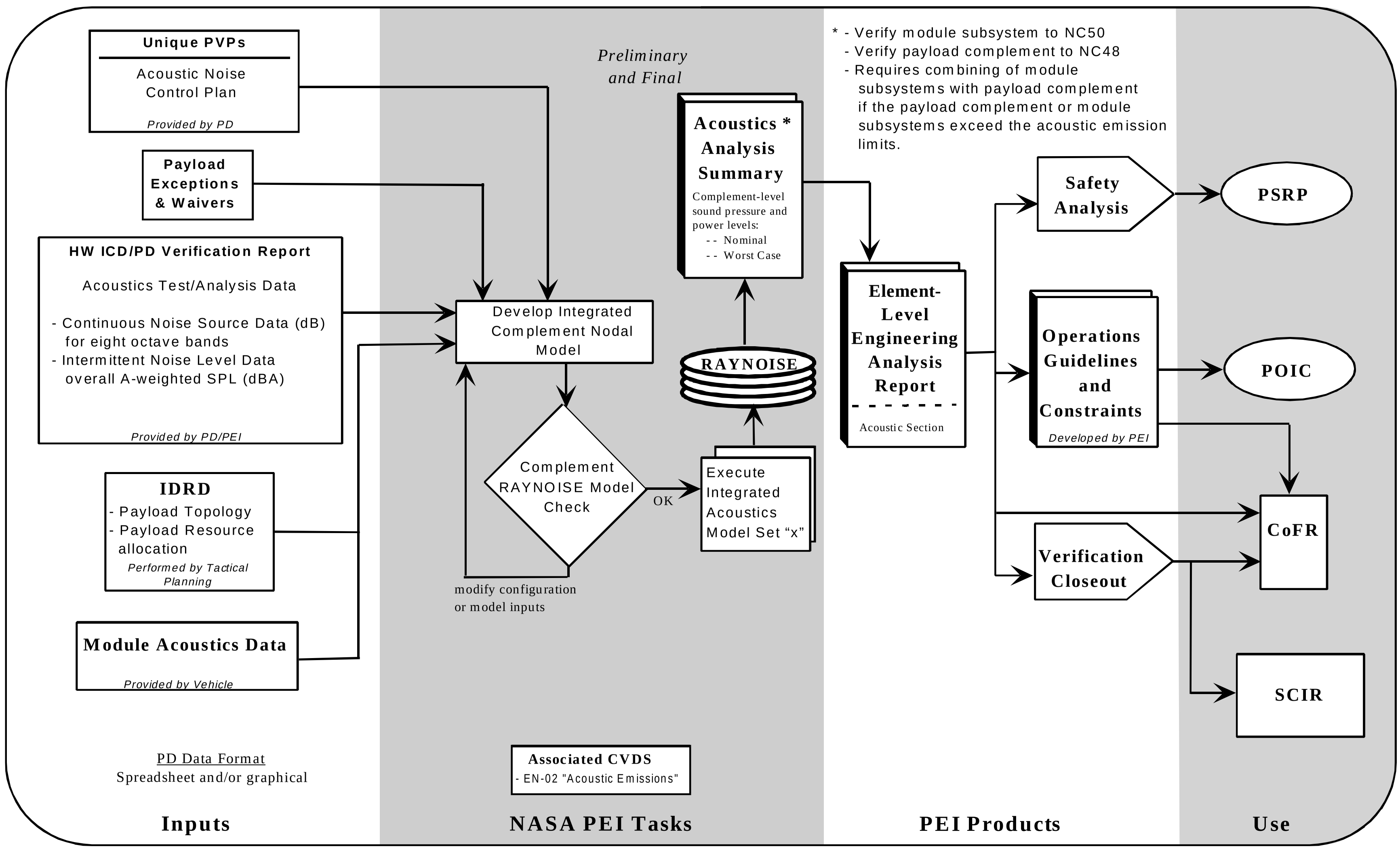

Figure 3.4.11-13: PEI Element-Level Acoustics Analysis Process

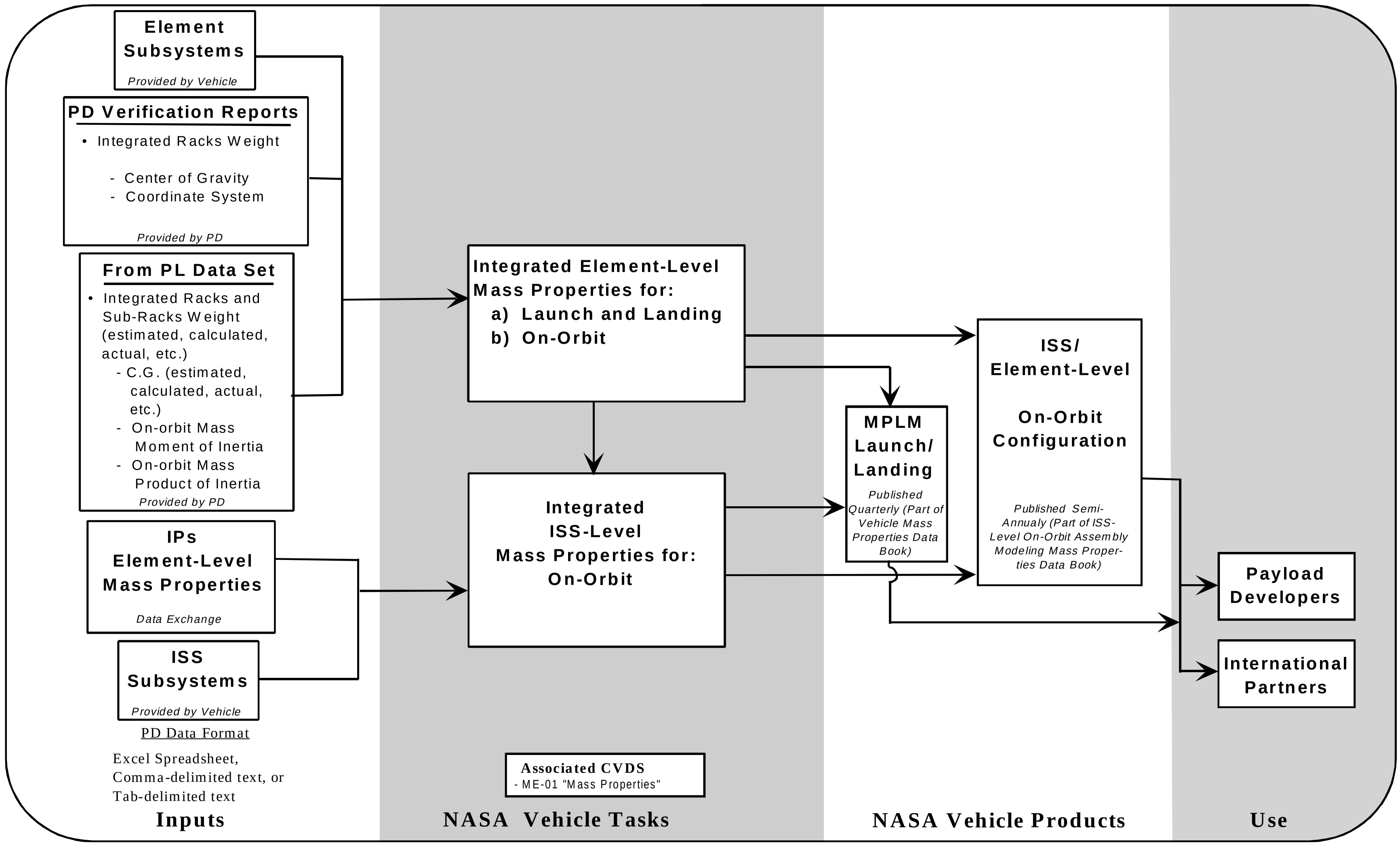

Figure 3.4.11-14: PEI Element-Level and ISS-Level Mass Properties Process

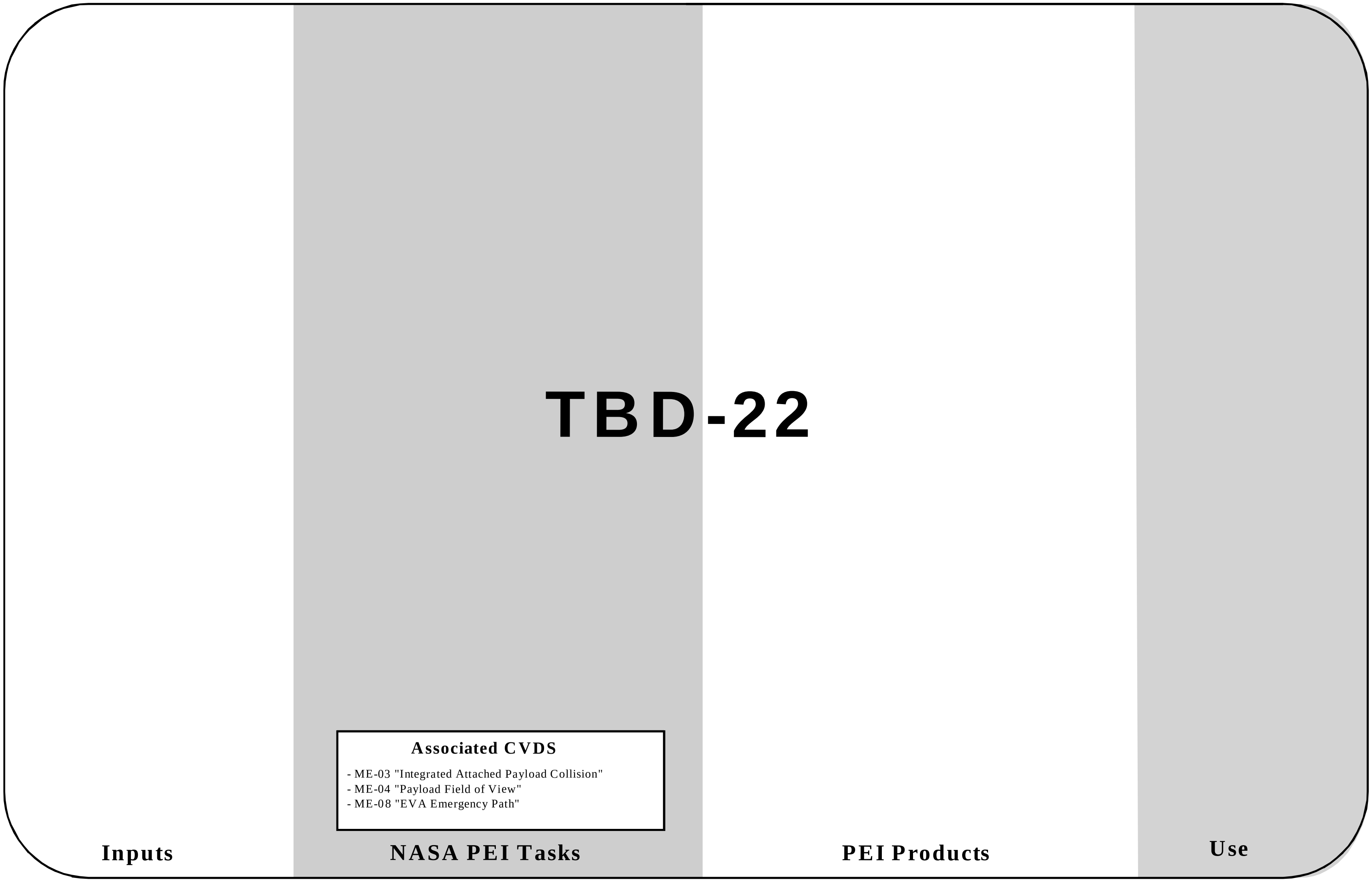

Figure 3.4.11-15: PEI Element-Level and ISS-Level Attached Payload Related Analysis Process

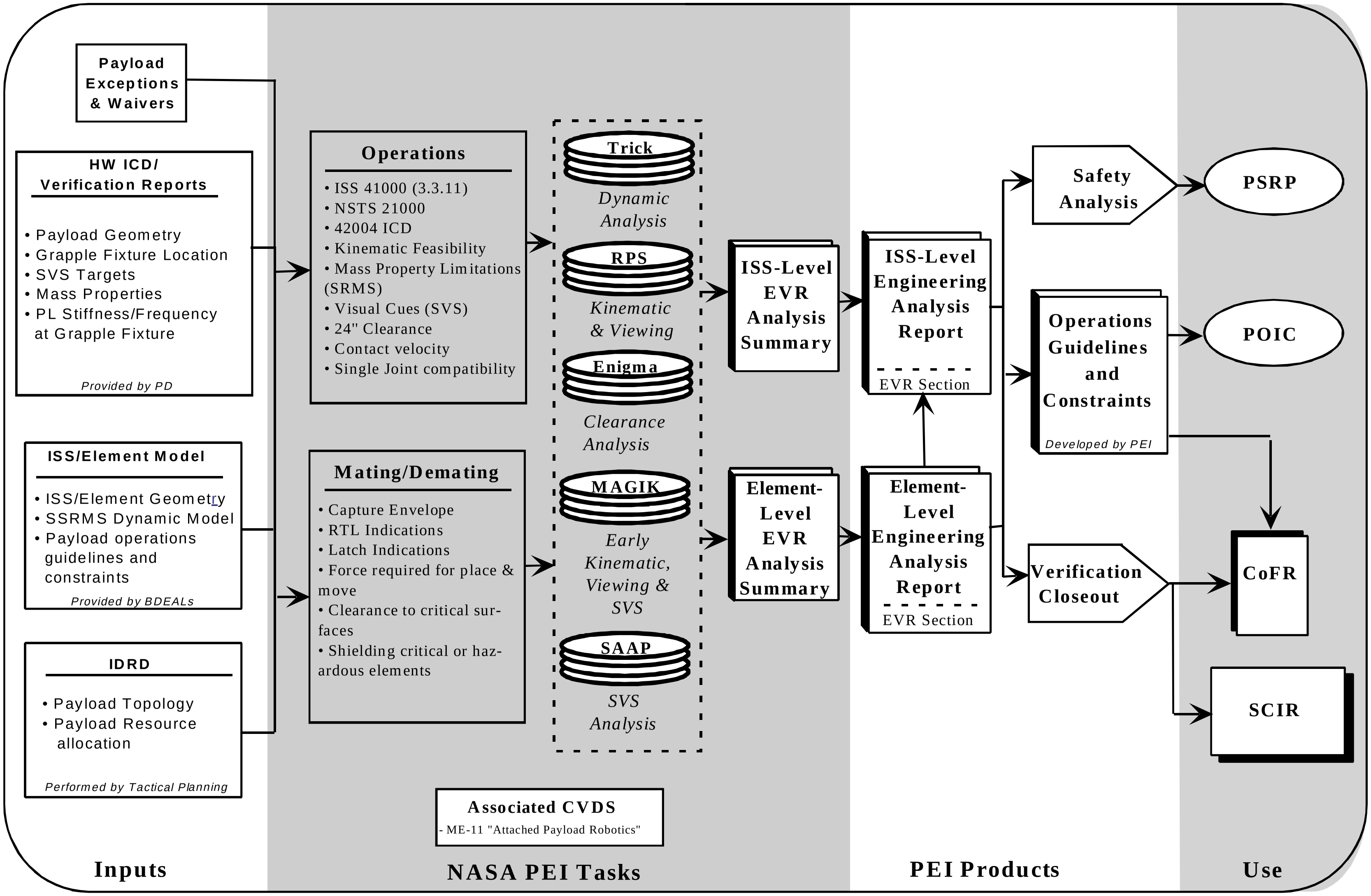

Figure 3.4.11-16: PEI Element-Level and ISS-Level Extravehicular Robotics Analysis Process (SRMS, SSRMS)

3.5 PAYLOAD VERIFICATION

Payload verification addressed in this section encompasses the unique aspects of verification of individual payloads as well as integrated payload racks, non-racks, external payload adapters and pallets.

Verification of individual payloads includes establishing compliance with all interface and safety requirements that are applicable to that payload, independent of other payloads which may share the same rack, pallet or container. In those cases where a rack, non-rack, external payload adapters or pallet is dedicated to a single payload, the entire integrated entity is treated both as an individual payload and as an integrated container for purposes of verification. In other words, it must meet all of the individual payload requirements, as well as all of the integrated-payload-container requirements.

Verification of integrated payload racks/non-racks/pallets/external payload adapters includes: (1) verification of compatibility with other payloads (if any) integrated into that entity; (2) verification of compliance with all the interface and safety requirements associated with integrating that group of payloads into that integrated rack or attached payload; and (3) compliance with the interface and safety requirements associated with integrating that container at the next higher level of assembly.

3.5.1 PAYLOAD VERIFICATION PLANNING

The responsibility for preparation of verification plans for integrated payload racks, non-racks, external payload adapters or pallets resides with the integrator of that entity (which, in some cases, is also the PD). These verification plans must also be submitted to and approved by the ISS Program, with later concurrence that the verification has been satisfactorily completed.

The verification plans for each of the following payload categories may be developed from generic PVPs provided by the element responsible partner. The PD may wish to modify the format of the VDSs that are given in the Generic PVPs; however, they should, in any case maintain the VDS numbering system and conform to the Detailed Description of Requirements as given therein. These generic PVPs are designed for specific classes of payloads as follows:

A. SSP 57010 Pressurized Payloads Generic Payload Verification Plan

B. SSP 57013 Generic Attached Payloads Verification Plan

C. TBD-6 Russian Aviation and Space Agency (ROSAVIACOSMOS) Module Generic Payload Verification Plan

D. TBD-7 JEM-EF Generic Payload Verification Plan

E. COL-RIBRE-PL-0144 Columbus Pressurized Payloads Generic Verification Plan

F. COL-RIBRE-PL-0145 Columbus External Payloads Generic Verification Plan

The above documents contain generic verification requirements tailored for these specific classes of payloads, the approved verification method(s) for each requirement, and the associated data submittal requirements. Designation of the applicability of the generic requirements to a specific case, and selection of a verification method where a choice is offered, converts the generic plan to a Unique PVP.

The schedule for delivery of the completed payload rack, non-rack, integrated external payload adapter and sub-rack verification plans to the ISS Program for review and approval is documented in the applicable PIA. Schedules for submittal of safety–related verification data and COC with all applicable verification requirements are governed by the schedules for safety reviews and the CAR, respectively, which are also documented in the PIA. However, submittal schedules for verification data required to support integrated payload complement analyses shall also be documented in the Unique PVP.

The ISS program, represented by each partner's PEI team, will provide support in the interpretation of requirements and associated specifications, as needed, to aid the development of the Unique PVPs. The completed verification plans will be considered an agreement between the ISS program and the PD or rack/non-rack/pallet/external payload adapter integrator. Therefore, the Unique PVPs require the signature of both parties.

3.5.2 PAYLOAD VERIFICATION IMPLEMENTATION

The implementation phase of payload verification encompasses all the activity required to execute the approved verification plan. Successful implementation leads to certification of payload interface and safety compatibility.

Individual PDs shall be responsible for performing the analyses, tests, demonstrations, and inspections that are required to verify compliance of their payload hardware and software with all the applicable requirements.

The rack/non-rack/external payload adapter/pallet integrator is responsible for doing the analyses, tests, demonstrations, and inspections that are required to verify compliance of the payloads with all applicable requirements. Data generated from these activities will be delivered to the partner's PEI Teams for element-level integration requirements verification and analysis. NASA's PEI team will be responsible for the ISS-level integration requirements, verification, and analysis. Because each of the element developers (NASA, ESA, and NASDA) are responsible for verification of their own elements, each partner has its own PEI team.

Any payload function designated for implementation using computer hardware or software that is provided by the ISS shall be subject to the program verification process for the hardware or software in question.

Any safety-related software or hazardous command shall be designated as such. For NASA Payloads, the Payload Software Interface Verification Facility (PSIVF) will be available to coordinate inputs and verification plans with Payload Developers to assure that payload/integrated rack to ISS data interfaces and software requirements are met, including hazardous command safety requirements.

Test and/or demonstration verification of the physical and functional interface compatibility of individual payloads and integrated payload racks/non-rack/pallets/external payload adapters with the ISS should be performed at distributed payload development/integration sites to the maximum extent practical. Simulators that replicate the ISS side of the interface for each class of payloads will be used.

Verification of payload compliance with environmental requirements, (such as EMI, acoustics, and material offgassing constituents), that require test facilities not available to the PD may be provided by the ISS program as an optional service. This will be subject to negotiation and agreement.

Data required to substantiate compliance with all applicable verification requirements for individual payloads or integrated payload racks/non-rack/pallets/external payload adapters shall be generated by the PD or integrator. Certificates of Compliance, Data Certifications and detailed data will be submitted in accordance with ISS program–approved unique payload verification plans.

Support by the ISS Program to PDs and/or payload rack/non-rack/pallet/external payload adapter integrators in the performance of verification implementation tasks, including data generation and documentation, shall be considered as an optional service and subject to negotiation and agreement.

3.5.3 PAYLOAD CERTIFICATION

The organization responsible for the development of verification plans, for individual payloads and/or integrated payload containers, will also be responsible to certify compliance with all applicable verification requirements as documented in the respective verification plan, even-though performance of some of the verification tasks may be delegated to another organization.

In those cases where racks/non-rack/pallets/external payload adapters are dedicated to a single payload and are integrated by the PD, the entire integrated entity will be treated as a payload and a single COC submittal by the PD shall be required. Submittal of COCs will be scheduled to coincide with the CoFR/FAR for that payload.

In those cases where payload racks/non-rack/pallets/external payload adapters are not dedicated to a single payload, the individual payloads to be integrated will be certified by the PDs at their respective CoFR/FAR and the integrated racks/non-rack/pallets/external payload adapters will be certified by the container integrator prior to installation in/on the payload. For sub-racks/sub-pallets that are moved from one rack/pallet to another, the sub-rack/sub-pallet PD will certify the payload for both locations.

3.5.4 PAYLOAD ON–ORBIT INSTALLATION/CHECKOUT

On-orbit checkouts will be done to ensure that the payload has been properly installed. The following documents and procedures establish resource requirements or how these check-outs will be performed:

A. ICDs shall be jointly developed by the PD/rack/non-rack/external payload adapter integrator and the element integrator. An ICD is required for each integrated payload rack, each EXPRESS Rack, and also for sub-rack payloads which specify ISS utility panel, or ISPR resource utilization. In addition, ICDs will be required for inter–rack resource connections for multi–rack facility-class payloads.

B. A standard crew procedure shall be developed for making the interface connections between an ISPR and the utility interface panel, and for the interface connections between an EXPRESS payload and an EXPRESS Rack.

C. A unique procedure shall be jointly developed by the crew procedure developers and the multi–rack-facility-class PD for making the inter–rack connections.

D. Checkouts will be performed to ensure proper functioning of quick-disconnect and vacuum/waste gas vent interfaces, and to ensure proper mating and conductivity through all electrical power and data connectors. The checkout procedure shall be jointly developed between the PD/rack integrator and the ISS Program crew procedures developer.

Truss attached payloads, APM EPF attached payloads and JEM-EF installation/checkout procedures are TBD-8.

3.6 PAYLOAD COMPATIBILITY VERIFICATION

The function of payload compatibility verification is to ensure that integration and operation of a complement of payloads is safe and compatible with the requirements of the individual payloads in the complement. This function also assures the compatibility of the operating complement with the ISS itself. Payload compatibility verification is not intended to duplicate the verification of the safety and interface compatibility of individual payloads and integrated payload racks/pallets. The element-level verification analysis addresses only those safety hazards and interface compatibility issues which result from the integration/operation of a complement of payloads that have been verified individually as safe and ISS compatible.

Payload compatibility verification at the element-level will be performed by NASA for NASA provided elements: the USL, the Centrifuge Accommodations Module (CAM), and the S3 truss element. Each partner’s PEI team will develop their own verification plans and will report verification of their elements to the ISS-level integrators.

Payload data at the integrated payload rack/pallet level shall be provided by each partner’s PEI team as an input to the logistics carrier complement verification. These data will be used to verify compliance with launch- and landing-related safety and interface requirements. The data may also be used for launch vehicle payload complement verification in cases where the payload is mounted directly to a launch vehicle.

All on–orbit payload compatibility verification at the element-level and ISS-level shall be conducted in accordance with the Payload Compatibility Verification Requirements contained in

Appendix C. International Partner (IP) element-level data (JEM, JEM-EF, APM) will be provided to the NASA PEI Team for incorporation into an ISS-level compatibility analysis.

Interfaces and functionality of NASA payload–specific software used in the ISS–provided avionics devices shall be verified prior to operation using a PSIVF for US payloads manifested for US Lab, APM, CAM, and JEM. ESA payloads manifested for APM will be verified prior to operation with the Rack Level Test Facility (RLTF). NASDA payloads manifested for JEM will be verified prior to operation with the TBD-23 facility. The PD and rack/pallet integrator shall support program verification activities of their software. Verification of payload software used in Portable Computer Systems (PCSs) located in the USL, which interface with US payloads in IP elements, are considered part of the USL element-level verification responsibility.

3.6.1 INTERNATIONAL PARTNERS VERIFICATION ACTIVITIES

The verification of payload complements compliance with timeline-independent safety and interface compatibility requirements shall be conducted by each partner organization consistent with their responsibilities for payload complement analytical integration. Each IP will be responsible for the element -level verification for their own element and the complement of payloads within it. Payload element-level verification will be conducted by each partner organization, consistent with their responsibilities for payload complement analytical integration. Verification closure for all applicable payload complement timeline–independent requirements shall be provided by each partner organization to the Multilateral Payloads Implementation and Control Board.

3.6.2 NASA SSP PAYLOAD COMPLEMENT VERIFICATION

The payload complement verification analyses, performed by payload engineering integration organizations in support of mission planning, deals with parameters that do not lend themselves to simple addition of discrete values in order to establish compliance with an aggregate limit, but rather require engineering analyses to establish the combined effect on a given parameter resulting from parallel payload and ISS operations. The payload operation’s constraints resulting from the ISS-level verification will further constrain some, if not all, element payload complements beyond those constraints identified at the element complement level. Therefore, close coordination between element and ISS payload complement verification activities is mandatory.

Reducing the number of payload combinations to be evaluated to a more manageable level can be achieved by a preliminary and final analysis cycle approach, with participation by each partner’s engineering integration organization.

The Operations Guidelines & Constraints document establishes broad operating constraints for simultaneous operations of certain payloads or classes of payloads. The responsibility for developing element-level operations guidelines and constraints for the USOS lies with NASA’s PEI Team. This team is also responsible for ISS-level operations guidelines and constraints. IPs element-level operations guidelines and constraints input will be provided by the partner’s PEI teams for incorporation into the ISS-level Operations Guidelines and Constraints document development. This information serves as a guideline for operating complement candidate selection by mission planning. These constraints shall include the results of a preliminary safety assessment.

3.6.3 PAYLOAD COMPLEMENT EXCEPTION HANDLING

Situations may arise where the planned payload complement, after analysis, is found to be in noncompliance with certain requirements. If, in the judgment of any partner's PEI Team, the noncompliance does not pose undue hazards to the overall Program, they may choose to request a waiver for the noncompliance. The Payload Control Board, Payload Safety Review Panel or Multilateral Payload Implementation Control Board (MPICB) will make the final decision on the permissibility of a waiver for each specific noncompliance that is found. The MPICB will only be used when partner element-level noncompliance impacts another partner's element or another partner's payload in a partner element. If the waiver is not approved, then new analyses or re-scheduling of particular payloads may be required.

3.7 PAYLOAD VERIFICATION STATUS TRACKING AND CLOSURE

NASA will develop and maintain a comprehensive database that provides the status of individual US payloads, US element-level, and ISS-level verification. The database will provide continuous and up-to-date status of these items for NASA and for each payload developer.

Closure of all verification items shall require satisfactory compliance with all data submittal requirements.

ABBREVIATIONS AND ACRONYMS

A	Analysis
AE	Attached Element
APID	Application Process Identification
APM	Attached Pressurized Module
APS	Automated Payload Switch
ATCS	Active Thermal Control System
BDEALs	Bilateral Data Exchange Agreement Lists
CAM	Centrifuge Accommodations Module
CDR	Critical Design Review
CD, C&DH	Command and Data Handling
CE	Conducted Emission
CG	Center of Gravity
CLA	Coupled Loads Analysis
cm	Centimeter
COC	Certificate of Compliance
CoFR	Certificate of Flight Readiness
COU	Concept of Operation and Utilization
CS	Conducted Susceptibility
CSA	Canadian Space Agency
CVDS	Compatibility Verification Definition Sheet
D	Demonstration
Db	Decibel
DbA	Decibel Atmospheric Pressure
DC	Direct Current
DDCU	DC-to-DC Converter Unit
DLA	Design Loads Analysis
e.g.	For Example
EL	Electrical
EMC	Electromagnetic Compatibility
EMI	Electromagnetic Interference
EN	Environmental
EPCE	Electrical Power Consuming Equipment
EPP	EXPRESS Pallet Payload
ERP	EXPRESS Rack Payload
ESA	European Space Agency
ESD	Electrostatic Discharge
etc.	Etcetera
EVA	Extravehicular Activity
EVR	Extravehicular Robotics
EXPRESS	EXpedite the PRocessing of Experiments to Space Station

ABBREVIATIONS AND ACRONYMS

FAR	Final Acceptance Review
FD	Fluid Dynamics
FEU	Flight Equivalent Unit
FGB	Functional Cargo Block [sic] (Functionalui Germaticheskii Block)
FLT	Flight
GA	Gases
GFE	Government Furnished Equipment
GNC	Guidance, Navigation, & Control
GPVP	Generic Payload Verification Plan
GSE	Ground Support Equipment
HDW	Hardware
HRFM	High Rate Frame Multiplexer
I	Increment
I/F	Interface
I/O	Input/Output
i.e.	That Is
ICD	Interface Control Document
IDRD	Increment Definition and Requirements Document
in	Inch
IP	International Partner
IRD	Interface Requirements Document
ISEAS	Integrated Space Station Electromagnetic Compatibility Analysis System
ISPR	International Standard Payload Rack
ISS	International Space Station
ISSP	International Space Station Program
IVA	Intravehicular Activity
JEM	Japanese Experiment Module
JEM-EF	Japanese Experiment Module Exposed Facility
Kbps	Kilobytes per Second
KSC	Kennedy Space Center
L	Launch
LAN	Local Area Network
LRDL	Low Rate Data Link
LTL	Low Temperature Loop
MCS	Monitor Control System
MDM	Multiplexer/Demultiplexer
ME	Mechanical
MO&UCB	Multilateral Operation and Utilization Control Board
MOD	Mission Operation Directorate

ABBREVIATIONS AND ACRONYMS

MPICB	Multilateral Payload Implementation Control Board
MPLM	Mini–Pressurized Logistics Module
MRDL	Medium Rate Data Link
MSD	Mass Storage Device
MTL	Moderate Temperature Loop
NASA	National Aeronautics and Space Agency
NASDA	National Space Development Agency of Japan
NASTRAN	NASA Structural Analysis Computer Program
NC	Noise Control
NSTS	National Space Transportation System
OOS	On–Orbit Operations Summary
ORU	Orbital Replacement Unit
OSTP	On-Orbit Short Term Plan
par	Paragraph
PCS	Portable Computer System
PD	Payload Developer
PDL	Payload Data Library
PE	Pressurized Element
PEHG	Payload Ethernet Hub Gateway
PEI	Payload Engineering and Integration
PES	Payload Executive Software
PIA	Payload Integration Agreement
PIM	Payload Integration Manager
PL, P/L	Payload
PMA	Pressurized Mating Adapter
POIC	Payload Operations Integration Center
PRCU	Payload Rack Checkout Unit
PRP	Pressurized Payloads
PSDE	Payload Software Development Equipment
PSIV	Payload Software Integration and Verification
PSIVF	Payload Software Interface Verification Facility
PSRP	Payload Safety Review Panel
PSP	Payload Safety Panel
PTCS	Passive Thermal Control System
PTE	Payload Test Equipment
PUI	Program Unique Identifier
PVP	Payload Verification Plan
PVPP	Payload Verification Program Policy
R&MA	Restraint and Mobility Aids
RE	Radiated Emission
RLTF	Rack Level Test Facility

ABBREVIATIONS AND ACRONYMS

ROSAVIACOSMOS	Russian Aviation and Space Agency
RS	Radiated Susceptibility
SCIR	Station Cargo Integration Review
SEA	Statistical Energy Analysis
SEED	Spacecraft Electrical Equipment Database
SEPS	Simulated Electrical Power System
SIP	Strategic Information Plan
SIR	Standard Interface Rack
SPIP	Station Program Implementation Plan
SPL	Sound Pressure Level
SRMS	Shuttle Remote Manipulator System
SS	Space Station
SSP	Space Station Program
SSPCB	Space Station Payload Control Board
SSMRS	Space Station Multi-Rigid Body Simulation
SSRMS	Space Station Remote Manipulator System
SW, S/W	Software
T	Test
TBD	To Be Determined
TCS	Thermal Control System
TS	Total Station
UOP	Utilization Operations Panel
US	United States
USL	United States Laboratory
USOS	U.S. On-orbit Segment
VDS	Verification Definition Sheet
VES	Vacuum Exhaust System
VLA	Verification Loads Analysis
VMDB	Vehicle Master Data Base

GLOSSARY OF TERMS

agreement – A documented recognition of the mutually understood requirements imposed on the ISSP and the PD or Facility-Payload Integrator, pertaining to the eventual integration and operation of the Customer's payload on board the ISS.

analysis – A technical evaluation process using techniques and tools such as mathematical models and computer simulation, historical/design/test data, and other quantitative assessments to calculate characteristics and verify specification compliance. Analysis is used to verify requirements compliance in cases where established techniques are adequate to yield confidence or where testing is impractical.

Analytical integrator – The party responsible for performing the analyses necessary to support the integration of a component (e.g., a rack, pallet, etc.).

attached payload – A payload that is designed to operate in an unpressurized environment. It is placed on board the ISS on an external attachment point (e.g., S3 Truss, JEM EF, etc.).

carrier – Structures that physically accommodate one or more pressurized racks, attached payloads, and/or external ORUs for ground integration into a launch vehicle for assembly on-orbit.

checkout – An on-orbit activity that follows installation of a rack/pallet, or the installation of a maintenance/repair component. It demonstrates that the rack, pallet or hardware item is in proper working order. This activity does not involve re-verification (see verification, below).

demonstration – The qualitative determination of compliance with requirements by observation during actual operation or simulation under preplanned conditions and guidelines.

deviation – A noncompliance proposed before the Payload-unique ICD is baselined. It may require additional analysis or control to eliminate risk and is acceptable when properly documented. It is referred to a Control Board for adjudication.

distributed verification – Verification of requirements is performed at various places, by the people who design and build the equipment, rather than by a centralized verification authority. In other words, at the payload/rack/pallet level, each group is responsible for checking their own work. Also, the International Partners who supply elements are responsible for the element-level verification.

element – A major component of the ISS. For example, in the NASA program, a pressurized module or an attached payload site is considered an element. For ESA, a single element may accommodate both pressurized and external attached payloads (e.g. APM).

Element-level – Verification of a pressurized module which includes the payload complement and the pressurized module subsystems, or an attached payload with associated ISS subsystems outside the pressurized module

element-level payload complement – A collection of payloads that share a common spacecraft element and associated resources, i.e., S3 truss payload complement, lab module payload complement.

GLOSSARY OF TERMS

exception: – A general term for any payload-proposed departure from requirements or interfaces. They may be further classified as exceedances, deviations, or waivers

exceedance: – A condition that does not comply with stated requirements but does not add any risk due to intended usage or configuration, and can be shown to be acceptable without special analysis or controls. Exceedances refer to exceptions that are identified prior to baselining of the Payload-Unique ICD. They must be approved by the appropriate discipline and management authority.

experiment – A test or trial undertaken to discover or demonstrate something. On Stations, this would be an activity performed using a payload, with or without human assistance.

EXPRESS Pallet – An attachment point platform with additional hardware for accommodating smaller attached payloads via EXPRESS Pallet adapters.

EXPRESS Rack – An ISPR with additional hardware for accommodating small sub–rack payloads, such as those in Shuttle middeck lockers and Standard Interface Rack (SIR) drawers.

facility–class payload – A payload pre–installed with hardware subsystems for supporting a variety of experiments. Experiment–specific hardware is modular and subject to support separately. Facility hardware will occupy one or more rack location and remains on board the ISS for many increments, but is not an element itself.

increment – A variable block of time between crew changeout.

inspection – A physical measurement or visual evaluation of equipment and associated documentation. Inspection is used to verify construction features, drawing compliance, workmanship, and physical condition.

Integrator - A group that assembles multiple subcomponents to make one larger component.

International Space Station – The first space station to be comprised of major elements from many nations, including the United States, Russia, Europe, Japan, Canada, and Italy. The ISS is a place for humans to perform scientific and commercial research to improve the lives of others on Earth and in space.

International Space Station Program – The international organization responsible for ISS design, construction, operation, and utilization. Utilization consists of payload integration and payload operations.

IP-equivalent – The International Partner equivalent piece of equipment, hardware or software.

ISS-level – Verification of multiple elements

ISS Program – A cooperative international program involving the following partners; The Canadian Space Agency (CSA), ESA, NASA, NASDA, and ROSAVIACOSMOS.

ISS program–provided – Provided by the ISS program to the Customer for use on the ground and/or in space. ISS program–provided items are provided only on Customer request, and usually for a fee.

Non-Rack Payload – Payload that is mounted and operated in the module aisle and requires power from a UOP or equivalent.

payload – The load carried by a vehicle exclusive of what is necessary for its operation; especially, the load carried by an aircraft or spacecraft consisting of things (as passengers or instruments) necessary to the purpose of the flight. In the context of this document, payload refers to equipment that is used to conduct scientific or engineering research. In most cases, payloads will consist of a fully-integrated ISPR or pallet that interfaces and functions with the mechanical, thermal, electrical and data accommodations provided by the ISS. In other cases, the payload may be integrated into a rack, external payload adapter or pallet along with other, unrelated payloads. Thus the payload can be any size or shape, ranging from one that could fit in a stowage drawer or middeck locker location, to one that occupies several rack locations (see **facility–class payload**) or an entire external pallet. Payloads are classified as either facility-class payloads or sub-rack/sub-pallet payloads. The Payload Engineering Integration function of the ISS program deals almost exclusively with facility-class payloads. Sub-rack payloads are typically managed by the payload developer, who integrates the sub-rack payloads into the EXPRESS rack or the facility-class payload.

Payload Engineering & Integration– The organization responsible for analytical integration of a payload rack/non-rack payload/integrated external payload adapter/pallet or payload hardware to comply with ISS/SSP imposed design–to specification, accommodations and constraints, and safety requirements. This payload organization will establish applicable payload verification and safety requirements and perform all required analytical verification tasks associated with an ISS program–approved verification plan.

payload complement – A group of payloads. This can be used in connection with any grouping of payloads for any reason. For example, a certain group of payloads that are launched at one time, a group of payloads that reside in the same module, all the payloads on Station at a given time, or a group of payloads that are active at the same time.

Payload Developer – The organization or individual who has been chosen by the Payload Sponsor to design, fabricate, verify, and deliver the payload hardware, software, and supporting equipment (instruments or facilities) to the ISS program for integration into the ISS. A Payload Sponsor may also be the PD. The organization responsible for overall design, fabrication, integration, and operation of the payload.

Pressurized Payload – A pressurized payload consists of the experiment complement integrated into a rack and non-rack payload items, (i.e., hardware requiring access to and resources from a UOP, or any EPCE configuration residing in a module).

Station Cargo Integration Review - The SCIRs are conducted for utilization and logistics flights to ensure that the necessary integration agreements, engineering analyses, and operations compatibility assessments are complete to support integration of ISS cargo into ISS cargo carriers (e.g., MPLM) and the on-orbit ISS.

stage – After the Orbiter leaves, whatever configuration the station is in at that point. Stage 1AR is just the FGB. Stage 2A would be the FGB, the Node, and the two Pressurized Mating Adapters (PMAs). A Stage-only configuration is a stand-alone station after the Orbiter leaves.

sub-pallet payload – An attached payload that does not occupy all of the available resources of an EXPRESS pallet or other external payload facility, but instead shares the pallet with other small payloads.

sub-rack payload – A small payload that can be installed in an ISPR after it is on-orbit. There can be several sub-rack payloads in each ISPR, and they can be easily removed or replaced.

test – The actual operation of normally-instrumented equipment under simulated or flight-equivalent conditions, or the subjection of parts or equipment to specified environments to measure and record responses in a quantitative manner.

Timeliner - 1) A planning/scheduling software tool used by MOD and POIC to develop the On-board Short-Term Plan (OSTP), which is the minute-by-minute on-orbit operations schedule. After it is built, the activity models that it generates ensures that the system can perform those activities.
2) The software that is used by the payload MDMs may be used to control the payload's operation. A timeliner script can be uplinked that gives a list of command and/or instructions to execute. When commanded, it automatically executes the instructions.

verification – To prove a thing to be true by evidence. In ISS usage, this means performing an analysis, an inspection, a demonstration, or a test. The inspection referred to here is different from a checkout (defined above) because it is static rather than dynamic (see definition for inspection above).

waiver – A noncompliance that is identified after the Payload-unique ICD is approved. It may be considered suitable "as-is" or it may require rework by an approved method. It must be approved by a Control Board.

C.1 INTRODUCTION

C.1.1 PURPOSE

This document establishes the requirements necessary to ensure that the integration and operation of ISS on–orbit payload complements are compatible with the requirements and constraints of the individual payloads at the element-level and the ISS-level.

Each ISS Program Partner shall comply with the provisions of this document consistent with their responsibilities for on–orbit payload compatibility verification.

C.1.2 SCOPE

The verification requirements contained in this document are limited to those that apply to establishing the interface compatibility of ISS on–orbit payload complements at the individual element-level and at the ISS-level.

C.2 DOCUMENT STRUCTURE

C.2.1 REQUIREMENTS APPLICABILITY MATRICES

All the requirements pertaining to on–orbit payload complement verification are listed in the Compatibility Verification Requirements Listing, Table C.2.1–1 (page C–5). The payload complement to which the requirement pertains, i.e., pressurized element (PE), attached element (AE) or total station (TS), is designated by a check mark in the appropriate complement column in the matrix. CVDS numbers shown on the matrix correspond to the CVDS pertaining to that requirement.

C.2.2 CVDSs

Each requirement listed on the requirements applicability matrix has a corresponding CVDS. The CVDSs document the specific requirements to be verified and describe the method to be employed, including essential input data and the data submittal requirements for that specific verification requirement.

In some cases, verification at the element-level will be indistinguishable from the verification at the ISS-level, and the two will be accomplished simultaneously. In such cases, a single CVDS will serve both element-level and ISS- level verification.

The CVDS form (Figure C.2.2–1) is separated into two parts—the header and the body.

<table>
<tr><td>Verification Number

AA/NN</td><td>Title

EXAMPLE CVDS</td><td>Verification Level

Element/ISS</td><td>Method

A/D/T</td></tr>
<tr><td colspan="4">Verification Requirement:
The clear statement of requirement for which compliance must be verified.</td></tr>
<tr><td colspan="4">Detailed Description of Requirement:

Instructions and details suggesting how the verification method(s), as identified in the header, should be implemented (what analyses, tests, or demonstrations are required and implementation details). In addition, any related clarification deemed necessary to further explain what is required will be provided.</td></tr>
<tr><td colspan="3">Verification Output:

1. Preliminary data that is required for input into the ISS Element-Level Verification Report.

2. Final data that is required for input into the ISS Element-Level Verification Report.</td><td>Submittal Dates:

I. Preliminary Data Due Date

II. Final Data Due Date</td></tr>
<tr><td colspan="4">Applicable Document(s) and Notes:

Listing of any documents that are applicable to the identified verification requirements, and any notes that contain relevant information not applicable for other parts of the CVDS.</td></tr>
<tr><td>Preliminary Input Data Source:
Example Input Data Source
Unique PVP (Draft)
Unique Payload HDW ICD (Draft)
Unique Payload S/W ICD (Draft)
PIA Addenda (Draft)</td><td>Input Date:</td><td>Final Input Data Source:
Example Input Data Source
Unique PVP (Final)
Unique Payload HDW ICD (Final)
Unique Payload S/W ICD (Final)
PIA Addenda (Final)</td><td>Input Date:</td></tr>
</table>

FIGURE C.2.2-1 CVDS FORM

C.2.2.1 CVDS HEADER

The header is used for identification and tracking purposes and contains:

A. Number

(1) (2)

AA –NN

(1) Discipline Identifier [2 digits (alpha)]

ME – Mechanical (includes Human Factors)
EL – Electrical
CD – Command & Data Handling
FD – Fluid Dynamics (Thermal Control, Vacuum, and Gases)
EN – Environmental

(2) Numerical Sequence NN [2 digits (numeric)]
Use all digits - 01, 02, etc. This number represents sequential numbering of the CVDSs by discipline. Example ST-03. This is the third CVDS within the structures discipline.

B. Title

The title is a category identification of a system level requirement or a derived requirement.

C. Verification Level

Identifies whether the CVDS applies to the elements, the ISS, or both the elements and the ISS.

D. Method

Verification of payload complements is accomplished by analyses, with the exception of software, which is accomplished via test and demonstration. The compatibility analyses may require test data as an input from individual payload or integrated rack/pallet level verification. The verification method block in the header will indicate the verification method: Analysis (A), Test (T), or Demonstration (D).

(1) Analysis

Analysis is the technical evaluation process of using techniques and tools such as mathematical models and computer simulations, historical/design/test data, and other quantitative assessments to calculate characteristics and verify specification compliance. Analysis is used to verify requirements where established techniques are adequate to yield confidence or where testing is impractical.

(2) Test

Test is actual operation of equipment, normally instrumented, under simulated or flight equivalent conditions or the subjection of parts or equipment to specified environments to measure and record responses in a quantitative manner.

(3) Demonstration

Demonstration is the qualitative determination of compliance with requirements by observation during actual operation or simulation under pre-planned conditions and guidelines.

C.2.2.2 CVDS BODY

The body of the CVDS contains the following:

E. Verification Requirement

A description of the requirement for which compliance must be verified to ensure payload complement interface compatibility and safety is provided.

F. Detailed Description of Requirement

Instructions and details documenting how the verification method identified in the header should be implemented are provided.

G. Required Verification Data

Data that is to be produced to show compliance with the verification requirement.

H. Applicable Documents and Notes

This section will be used to identify applicable documentation to provide assistance in accomplishing the specified verification requirements. The references will be detailed with specific paragraphs and/or sections referenced where possible. This section of the CVDS will also contain additional notes that are not directly related to other sections of the CVDS.

C.3 PAYLOAD COMPATIBILITY VERIFICATION PROCESS

Payload compatibility verification is an iterative process. As discussed in sections 3.2.2 and 3.6.1, some requirements are independent of the operating timeline (timeline-*in*dependent), but others (timeline-*related*) are not (Reference Figures 3.4.11-1b through 3.4.11-16).

TABLE C.2.1-1 COMPATIBILITY VERIFICATION REQUIREMENTS LISTING

CVDS NO.	VERIFICATION REQUIREMENT TITLE	ISS-LEVEL	PRESSURE ELEMENT	ATTACHED ELEMENT	APPENDIX C PAGE NO.	RELATED FIGURE
ME-01	MASS PROPERTIES	✔	✔	✔	C-7	3.4.11-14
ME-02	PRESSURIZED PAYLOAD WORK VOLUMES		✔		C-8	3.4.11-12
ME-03	INTEGRATED ATTACHED PAYLOAD COLLISION	**TBD-11**			C-9	3.4.11-15
ME-04	PAYLOAD FIELD OF VIEW	**TBD-12**			C-10	3.4.11-15
ME-05	CREW TRANSLATION PATH		✔		C-11	3.4.11-12
ME-06	EQUIPMENT TRANSLATION PATH		✔		C-12	3.4.11-12
ME-07	IVA EMERGENCY EGRESS PATH		✔		C-13	3.4.11-12
ME-08	EVA EMERGENCY PATH			**TBD-14**	C-14	3.4.11-15
ME-09	VISIBILITY AND ACCESS TO CRITICAL EQUIPMENT AND CONTROLS		✔		C-15	3.4.11-12
ME-10	ATTACHED PAYLOAD ROBOTICS	**TBD-16**		**TBD-16**	C-16	3.4.11-16
EL-01	ELEMENT-LEVEL PRESSURIZED/ATTACHED PAYLOADS EMI/EMC		✔	✔	C-17	3.4.11-3
EL-02	ISS-LEVEL PRESSURIZED/ATTACHED PAYLOADS EMI/EMC	✔			C-18	3.4.11-153
EL-03	ELECTRICAL POWER SYSTEM STABILITY		✔		C-19	3.4.11-2
EL-04	CHANNELIZED POWER/THERMAL ANALYSIS	✔	✔	✔	C-20	3.4.11-6
CD-01*	PAYLOAD MDM COMPLEMENT CONFIGURATION		✔		C-21	3.4.11-4
CD-02*	PAYLOAD MSD RESOURCE UTILIZATION		✔		C-22	3.4.11-4
CD-03*	TIMELINER CONFIGURATION AND UTILIZATION		✔		C-23	3.4.11-4
CD-04*	PCS PAYLOAD DISPLAYS AND APPLICATIONS SOFTWARE		✔		C-24	3.4.11-4
CD-05*	PAYLOAD 1553B AND ETHERNET DATA BUS LOADING		✔		C-25	3.4.11-4
CD-06*	PAYLOAD DATA LINK AND SOFTWARE SERVICES ASSESSMENT		✔		C-26	3.4.11-4
FD-01	INTEGRATED TRUSS ELEMENT THERMAL COMPATIBILITY			**TBD-19**	C-27	3.4.11-5

TABLE C.2.1-1 COMPATIBILITY VERIFICATION REQUIREMENTS LISTING

CVDS NO.	VERIFICATION REQUIREMENT TITLE	ISS-LEVEL	PRESSURE ELEMENT	ATTACHED ELEMENT	APPENDIX C PAGE NO.	RELATED FIGURE
FD-02	FLUID AND ATMOSPHERE CONSUMABLES USAGE	✔	✔ **(JEM Only)**		C-28	3.4.11-7
FD-03	CO_2 PARTIAL PRESSURE	✔	✔		C-29	3.4.11-7
FD-04	VES ACCEPTABLE EXHAUST GASES		✔		C-30	3.4.11-9
FD-05	LATENT HEAT LOAD		✔		C-31	3.4.11-7
FD-06	EXTERNAL CONTAMINATION/VENTING	✔	✔	**TBD-24**	C-32	3.4.11-8
FD-07	PRESSURIZED ELEMENT THERMAL COMPATIBILITY		✔		C-33	3.4.11-10
EN-01	MICROGRAVITY	✔	✔	✔	C-34	3.4.11-11
EN-02	ACOUSTIC EMISSIONS		✔		C-36	3.4.11-13

* NASA Managed Only

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
ME-01	MASS PROPERTIES	Element & ISS	A

Verification Requirement: Integrate the Payload Complement, Element-Level and ISS-Level Mass Properties.
Detailed Description of Requirement: Gather all the integrated racks mass properties to generate the Payload Complement, Element-Level, and ISS-Level Mass Properties.

Verification Output:	Submittal Dates:
1. Element-Level Mass Properties including payload complement addressing: a) Launch/Landing Configuration b) On-Orbit Configuration	1. Element-Level a) Quarterly Mass Properties (posted to the Vehicle Master Database (VMDB) b) Semi-Annually ISS-Level On-Orbit Assembly Modeling Mass Properties Data Book
2. ISS-Level Mass Properties including payload complement addressing: On-Orbit Configuration	2. ISS-Level a) Quarterly Mass Properties (posted to the Vehicle Master Database (VMDB) b) Semi-Annually ISS-Level On-Orbit Assembly Modeling Mass Properties Data Book

Applicable Document(s) and Notes: Quarterly Mass Properties posted to VMDB LESC-31166/JSC 26557 – ISS On-Orbit Assembly Modeling Mass Properties Data Book SSP 52000-PDS Rev. B in Section 9.3.2.1.5 SSP 574##; Unique PVPs, ME-001

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. PL Data Set in Section 9.3.2.1.5. (Pressurized Payload/Attached Payload–to-Element)	1. Quarterly beginning at L-20 with updates at L-17, L-14, L-11, and L-8	1. Unique PVPs ME-001 “Weight and C.G.” data. (Pressurized Payload/Attached Payload–to-Element) 2. PL Data Set in Section 9.3.2.1.5. (Pressurized Payload/Attached Payload–to-Element)	1. L-7 2. L-5
2. IPs Input – Element-Level Mass Properties (including payload complement)*. (Element-to-ISS) * project all the applicable stages up to 24 months	2. February and August 1st of each year	3. IPs Input – Element-Level Mass Properties (including payload complement). (Element-to-ISS)	3. L-4 per stage

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
ME-02	PRESSURIZED PAYLOAD WORK VOLUMES	Element	A

Verification Requirement:

Work volumes (i.e., adequate clearance) shall be provided at each payload station for crewmembers to perform the tasks and activities associated with that payload. The work volume shall include Restraints and Mobility Aids (R&MA), tools, ancillary equipment and supplies used to perform the tasks. Payloads requiring hardware extending (temporarily, permanently, or keep alive) into the aisle shall not collide with other hardware when protrusions are extended to the maximum envelope.

Detailed Description of Requirement:

An analysis shall be performed of all planned crew tasks at each payload crew station to show that adequate volume is available in the context of the "worst-case" configuration of the integrated element topology to accommodate the number and positioning of crewmembers and the necessary R&MA, tools, ancillary equipment, and supplies needed to carry out the tasks. The analysis shall be performed by placing both the 95% American male and the 5% Japanese female on the long duration foot restraints at each of the payload racks in the zero-gravity neutral body position. Operational constraints are identified if there are any obstacles in the crew work volume or collisions of hardware.

Note: Assumptions and Guidelines used to perform this analysis are as follows:

- All protrusions are extended to their maximum envelope.
- Foot restraints are placed 16.28 inches above the bottom of the rack to accommodate the 5% Japanese female and at the lowest seat track position to accommodate the 95% American male. These restraints are placed on the racks in a manner to represent the most confining envelope.
- ARIS equipped racks cannot accommodate R&MA or crewmembers while the ARIS is in operation.
- Items in transit that are not mounted, tethered, or attached to fixed structures are not considered to be obstructions of the pressurized payload work volume.

Verification Output:	Submittal Dates:
1. Preliminary Element-Level Analysis Summary.	1. L-15
2. Final Element-Level Analysis Summary	2. L-7

Applicable Document(s) and Notes:
SSP 52000-PDS; Payload Data Set and Envelope Drawings; par. 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4
SSP 54103; IDRD
SSP 572##; Unique Payload Hardware ICDs, Section 3.1.1.3
SSP 574##; Unique PVPs, ME-059

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs ME-059, "Payload Protrusions"	1. L-20	1. Unique PVPs ME-059, "Payload Protrusions"	1. L-12
2. Unique Payload HDW ICDs Section 3.1.1.3 data	2. L-20	2. PL Data Set, per 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4	2. L-10
		3. Payload exceptions and waivers (if any)	3. L-12

Verification Number	Title	Verification Level	Method
ME-03	INTEGRATED ATTACHED PAYLOAD COLLISION	ISS	A

Verification Requirement:

The integrated attached payload and elements shall be analyzed to ensure that collisions do not occur due to premature/inadvertent appendage deployment, Payload Articulation, or vehicle system operations.

Detailed Description of Requirement:

TBD-11

Verification Output:	Submittal Dates:
1. Preliminary ISS-level analysis summary	1. L-11
2. Final ISS-level analysis summary	2. L-5

Applicable Document(s) and Notes:

TBD-11

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
TBD-11	TBD-11	TBD-11	TBD-11
1. IP inputs TBD-18	1. L-15	1. IP inputs TBD-18	1. L-11

Verification Number	Title	Verification Level	Method
ME-04	PAYLOAD FIELD OF VIEW	ISS	A

Verification Requirement:

Assess Attached Payload Field of View requirements for compatibility with adjacent Payloads and ISS configurations.

Detailed Description of Requirement:

Assess that the field of view requirements of all Payloads in the attached Payload element complement are met. Analyze the external configuration drawings of all payloads in the complement, and the external envelope drawings of the ISS, and show that the attached element Payload Complement layout is compatible with the Payload field of view requirements.

Verification Output:	Submittal Dates:
1. Preliminary ISS-level analysis summary	1. L-11
2. Final ISS-level analysis summary	2. L-5

Applicable Document(s) and Notes:

TBD-12

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
TBD-12	TBD-12	TBD-12	TBD-12
1. IP inputs TBD-18	1. L-15	1. IP inputs TBD-18	1. L-11

<table>
<tr><td>Verification Number
ME-05</td><td>Title
CREW TRANSLATION PATH</td><td>Verification Level
Element</td><td>Method
A</td></tr>
<tr><td colspan="4">Verification Requirement:

The integrated Payload Configurations of each ISS element shall provide translation paths for the routine (non-emergency) movement of crew within the module. Translational paths are defined as a 72 inch by 32 inch rectangular path fixed at hatch openings at both ends of the module.</td></tr>
<tr><td colspan="4">Detailed Description of Requirement:

An analysis shall be performed by generating a 72 inch by 32 inch rectangular path through the module. Although the crew translation path may bend; a rectangular path of 72 inches by 32 inches shall be maintained. Constraints are identified if there are any obstacles in the crew translation path.

Note: Assumptions and Guidelines used to perform this analysis are as follows:
• All protrusions are extended to their maximum envelope.
• Foot restraints are placed 16.28 inches above the bottom of the rack to accommodate the 5% Japanese female.
• ARIS equipped racks cannot accommodate R&MA while the ARIS is in operation.
• Items in transit that are not mounted, tethered, or attached to fixed structures are not considered to be obstructions of the crew translation path.
• Handrails are not considered protrusions in this analysis, as they are aids for the crew to maneuver though the USL.</td></tr>
<tr><td colspan="3">Verification Output:

1. Preliminary element-level analysis summary

2. Final element-level analysis summary</td><td>Submittal Dates:

1. L-15

2. L-7</td></tr>
<tr><td colspan="4">Applicable Document(s) and Notes:

SSP 50005; ISS Flight Crew Integration Standard
SSP 52000-PDS; Payload Data Set and Envelope Drawings; par. 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4, Unique Payload On-Orbit and Assembly and Installation Drawings
SSP 54103; IDRD
SSP 572##; Unique Payload Hardware ICDs, Section 3.1.1.3
SSP 574##; Unique PVPs, ME-059</td></tr>
</table>

<table>
<tr><td>Preliminary Input Data Source:

1. Unique PVPs ME-059, “Payload Protrusions”

2. Unique Payload HDW ICDs Section 3.1.1.3</td><td>Input Date:

1. L-20

2. L-20</td><td>Final Input Data Source:

1. Unique PVPs ME-059, “Payload Protrusions”

2. Payload Data Set, per 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4

3. Payload exceptions and waivers (if any)</td><td>Input Date:

1. L-12

2. L-10

3. L-12</td></tr>
</table>

Verification Number ME-06	Title EQUIPMENT TRANSLATION PATH	Verification Level Element	Method A

Verification Requirement:

The integrated Payload Configurations of each ISS element shall provide translation paths for the routine (non-emergency) movement of equipment (e.g., racks) within pressurized modules. The equipment translation path is defined as a 50 inch by 50 inch square path fixed at both ends of the module.

Detailed Description of Requirement:

An analysis shall be performed by generating a 50 inch by 50 inch square path through the module. Although the equipment translation path may bend, a square path of 50 inches by 50 inches shall be maintained. Although the equipment translation path may flex, it must accommodate the translation of an International Space Station Payload Rack (ISPR).

Note: Assumptions and guidelines used to perform the analysis are as follows:

- Momentary protrusions (e.g., doors, drawers), temporary protrusions (e.g., glovebox), foot restraints, and other aisle mounted hardware (e.g., ergometer) will be removed. In the event of rack translation, such protrusions would likely be bumped and damaged if left in the aisle. The Robotics Workstation will be left in place as it will likely be in use during rack translation.
- Semi-permanent protrusions and protrusions for keep alive payloads will remain deployed.
- Items in transit that are not mounted, tethered, or attached to fixed structures are not considered to be obstructions of the equipment translation path.
- Handrails are considered protrusions in this analysis, as they could inhibit the transfer of equipment.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary 2. Final element-level analysis summary	1. L-15 2. L-7

Applicable Document(s) and Notes:

SSP 52000-PDS; Payload Data Set and Envelope Drawings; par. 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4, Unique Payload On-Orbit and Assembly and Installation Drawings
SSP 54103; IDRD
SSP 572##; Unique Payload Hardware ICDs, Section 3.1.1.3
SSP 574##; Unique PVPs, ME-059

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs ME-059, “Payload Protrusions” 2. Unique Payload HDW ICDs Section 3.1.1.3	1. L-20 2. L-20	1. Unique PVPs ME-059, “Payload Protrusions” 2. Payload Data Set, per 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4 3. Payload exceptions and waivers (if any)	1. L-12 2. L-10 3. L-12

Verification Number	Title	Verification Level	Method
ME-07	IVA EMERGENCY EGRESS PATH	Element	A

Verification Requirement:

The integrated Payload Configurations within each ISS element shall maintain an IVA emergency egress path during all ISS operations. The IVA emergency egress path is defined as a 32 inch diameter continuous flexible tube fixed at hatch openings at both ends of the module.

Detailed Description of Requirement:

An analysis shall be performed by generating a 32 inch continuous flexible tube through the module. Although the IVA emergency egress path may bend, a 32 inch continuous flexible tube must be maintained. Constraints are identified if there are any obstacles in the IVA emergency egress path.

Note: Assumptions and guidelines used to perform this analysis are defined as follows:

- All protrusions are extended to their maximum envelope.
- Foot restraints are placed 16.28 inches above the bottom of the rack to accommodate the 5% Japanese female.
- ARIS equipped racks cannot accommodate R&MA while ARIS is in operation.
- Items in transit that are not mounted, tethered, or attached to fixed structures are not considered to be obstructions of the IVA emergency egress path. An example of items not considered obstructions are racks being moved through hatch openings. These racks can be moved rapidly out of the path in an emergency situation.
- Handrails are not considered protrusions in this analysis, as they are aids for the crew to maneuver through the module.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Final element-level analysis summary	2. L-7

Applicable Document(s) and Notes:

SSP 52000-PDS; Payload Data Set and Envelope Drawings; par. 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4
SSP 54103; IDRD
SSP 572##; Unique Payload Hardware ICDs, Section 3.1.1.3
SSP 574##; Unique PVPs, ME-059

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs ME-059, "Payload Protrusions"	1. L-20	1. Unique PVPs ME-059, "Payload Protrusions"	1. L-12
2. Unique Payload HDW ICD Table 3.1.1.3	2. L-20	2. Payload Data Set, per 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4	2. L-10
		3. Payload exceptions and waivers (if any)	3. L-12

Verification Number	Title	Verification Level	Method
ME-08	EVA EMERGENCY PATH	Element	TBD-14

Verification Requirement:

Verify that there are adequate crew translation corridors, for attached payloads on the S3 segment, for emergency crew translation.

Detailed Description of Requirement:

TBD-14

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary 2. Final element-level analysis summary	1. L-15 2. L-7

Applicable Document(s) and Notes:

TBD-14

Note: Done only for exceptions to the Attached Payload IRD envelope requirements.

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
TBD-14	1. L-20	TBD-14	1. L-12

Verification Number	Title	Verification Level	Method
ME-09	VISIBILITY AND ACCESS TO CRITICAL EQUIPMENT AND CONTROLS	Element	A

Verification Requirement:

All critical equipment and controls, including but not limited to rack maintenance switches, caution and warning labels, fire detection indicators, and fire suppression access ports, shall be visible and accessible at all times.

Detailed Description of Requirement:

An analysis shall be performed to ensure visibility and access to all critical equipment and controls during all ISS operations. Continuous visibility and access to rack maintenance switches (rack power switches), caution and warning labels, fire detection indicators, and fire suppression access ports are defined by a centered 28 inch, 30° cone, with the apex at the critical control, and perpendicular to the critical control. Access to the fire suppression access port is defined by the unobstructed insertion of the portable fire extinguisher and tube [19.2 inch long bottle, 10 inch long extinguisher tube (from edge of bottle), 1 inch diameter access cylinder] to the fire suppression access port. Access to other critical equipment items and controls is defined in the payload unique ICD (i.e., EXPRESS sub-rack front inlet and outlet areas). Constraints are identified if there are any obstacles to visibility or access to critical equipment and controls. This analysis is based on the following assumptions and guidelines:

- All protrusions are extended to their maximum envelope.
- Foot restraints are placed 16.28 inches above the bottom of the rack to accommodate the 5% Japanese female.
- ARIS equipped racks cannot accommodate R&MA while ARIS is in operation.
- Items in transit that are not mounted, tethered, or attached to fixed structures are not considered to be obstructions to the critical equipment and controls.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Final element-level analysis summary	2. L-7

Applicable Document(s) and Notes:

SSP 52000-PDS; Payload Data Set and Envelope Drawings; par. 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4
SSP 572##; Unique Payload Hardware ICDs, Section 3.1.1.3
SSP 574##; Unique PVPs, ME-040, ME-054, ME-055, and EL-028

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique Payload HW ICD Section 3.1.1.3 data	1. L-20	1. Unique PVPs ME-054, “Fire Detection Indicator” data	1. L-12
		2. Unique PVPs ME-055, “Fire Suppression Access Port” data	2. L-12
		3. Unique PVPs EL-028, “Rack Maintenance Switch (Rack Power Switch)” data	3. L-12
		4. Payload Data Set, per 9.1.2.2, 9.2.2.3, 9.3.2, 9.3.2.1, and 9.3.2.1.4	4. L-10
		5. Payload exceptions and waivers (if any)	5. L-12

Verification Number	Title	Verification Level	Method
ME-10	ATTACHED PAYLOAD ROBOTICS	Element & ISS	TBD-16

Verification Requirement:

Verify that Attached Payloads can be removed from the cargo bay and installed on the S3 attach sites without impact to other ISS hardware or payloads.

Detailed Description of Requirement:

TBD-16

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Preliminary ISS-level analysis summary	2. L-11
3. Final element-level analysis summary	3. L-7
4. Final ISS-level analysis summary	4. L-5

Applicable Document(s) and Notes:

TBD-16

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. IP inputs TBD-18	1. L-15	1. IP inputs TBD-18	1. L-8

COMPATIBILITY VERIFICATION DEFINITION SHEETS

<table>
<tr><td colspan="2">Verification Number

EL-01</td><td colspan="2">Title
ELEMENT-LEVEL PRESSURIZED/ATTACHED PAYLOADS EMI/EMC</td><td>Verification Level

Element</td><td>Method

A</td></tr>
<tr><td colspan="6">Verification Requirement:

The Pressurized/Attached Payloads and Space Station Subsystems shall be compatible with each other and with the electromagnetic environment of the integrated element.</td></tr>
<tr><td colspan="6">Detailed Description of Requirement:

Perform an analysis of the Pressurized/Attached Payload Electromagnetic Interference/Electromagnetic Compatibility (EMI/EMC) data in order to verify the Pressurized/Attached Payload-to-Pressurized/Attached Payload and Pressurized/Attached Payload-to-Space Station Subsystems Complement-Level electromagnetic compatibility. Assessments will be performed using the payload EMI/EMC plans/Design Data Analysis and electrical schematics to ensure the design concept meets the requirements. The analysis requires review of Pressurized/Attached payloads and Space Station Subsystems EMI/EMC tests results with comparison of individual payload emissions exceedances and susceptibility.</td></tr>
<tr><td colspan="4">Verification Output:

1. Final EMI/EMC element-level analysis based upon complete payload test data addressing:
• Emissions • Lightning • ESD
• Susceptibility • Cable/Wire Design and Control Requirements
• Grounding and Bonding • Corona
• Isolation • Safety Critical Circuits</td><td colspan="2">Submittal Dates:

1. L-8</td></tr>
<tr><td colspan="6">Applicable Document(s) and Notes:
NSTS 1700.7 ISS Addendum, par. 212.2
SSP 30237, Entire Document
SSP 30238, Entire Document

SSP 574##; Unique PVPs, EL-019, EL-020, EL-021, EL-022, EL-024, EL-025
Note: PEI uses the Integrated Space Station Electromagnetic Compatibility Analysis System (ISEAS) to perform Element-Level EMI/EMC analysis.</td></tr>
<tr><td>Preliminary Input Data Source:
1. Unique PVPs Appendix F, “EMI/EMC Control, Test Plan, and Design Analysis Report”</td><td>Input Date:
1. L-22</td><td colspan="3">Final Input Data Source:
1 Unique PVPs, EL-019 “EMC for Safety-Critical Circuits”, Analysis & Test data
2. Unique PVPs, EL-020 “Electromagnetic Interference/Compatibility”, Analysis, Test, & Inspection data
3. Unique PVPs, EL-021 “Cable/Wire Design and Grounding”, Analysis & Test or Analysis, Test, & Inspection data
4. Unique PVPs, EL-022 “Bonding”, Analysis, Test, and Inspection data
5. Unique PVPs, EL-024 “ESD”, Analysis, Test & Inspection data
6. Unique PVPs, EL-025 “Lightning”, Analysis or Test data
7. Unique PVPs, EL-042 “Corona”, Analysis and Test Data
8. Electrical Schematics (from EMI/EMC Control Plan)
9. Payload exceptions and waivers (if any)</td><td>Input Date:
1. L-12
2. L-12
3. L-12
4. L-12
5. L-12
6. L-12
7. L-12
8. L-12
9. L-12</td></tr>
</table>

Verification Number	Title	Verification Level	Method
EL-02	ISS-LEVEL PRESSURIZED/ATTACHED PAYLOADS EMI/EMC	ISS	A

Verification Requirement:

Module elements and attached elements shall be compatible with each other, with the external ISS environment, and with the ISS core subsystems.

Detailed Description of Requirement:

Perform a ISS EMI/EMC analysis in order to verify the element to element (attached payload and pressurized module) meet the ISS-level EMI/EMC requirements of SSP 30237 and the element-level EMI/EMC requirements of SSP 57000. Assessments will be performed using the element-level EMI/EMC test/analysis data and electrical schematics to ensure the design concept complies with the requirements of SSP 30237 and SSP 57000. The analysis requires review of pressurized module, attached site (if any), attached payload (if any), and subsystem EMI/EMC tests results. In addition, a comparison of element/ISS emissions and susceptibilities shall be performed.

Verification Output:	Submittal Dates:
1. ISS-level EMI/EMC analysis summary	1. L-5

Applicable Document(s) and Notes:
NSTS 1700.7 ISS addendum; par. 212.2
SSP 30237; Entire Document
SSP 30238; Entire Document

Note: PEI uses ISEAS to perform element-level EMI/EMC analyses for the USL and attached payloads.

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
N/A	N/A	1. All attached payload EMI/EMC test/analysis results and schematics (from EL-01)	1. L-8
		2. All pressurized module EMI/EMC test/analysis results and schematics (from EL-01)	2. L-8
		3. IPs inputs (including payload operations guidelines and constraints)	3. L-8
		4. all module element and attached payload exceptions and waivers (if any)	4. L-8

Verification Number EL-03	Title ELECTRICAL POWER SYSTEM STABILITY	Verification Level Element	Method A
Verification Requirement: The integrated Payload complement shall be compatible with the electrical power system such that electrical power stability is assured.			
Detailed Description of Requirement: Verify by analysis the Payload Complement-level electrical power system stability. Perform analysis of the Payload complement input impedances, large signal stability*, and electrical load stand-alone stability* data in order to verify the complement-level electrical power system stability. Stand-alone data consists of standard Payload EMI/EMC test data as required.			
Verification Output: 1. Preliminary element-level **assessment** addressing: • Load Impedance • Large Signal Stability • Reverse Energy/Current • Surge Current 2. Final element-level Analysis summary addressing: • Stand-Alone Load Stability • Large Signal Stability • Load Impedance • Reverse Energy/Current • Surge Current • EMI/EMC		Submittal Dates: 1. L-15 2. L-7	
Applicable Document(s) and Notes: SSP 30482 SSP 572##; Unique Payload Hardware ICDs, par. 3.2.5, and 3.2.7 SSP 574##; Unique PVPs, EL-002, EL-010, EL-011, EL-014, EL-015, EL-016, EL-020, and EL-023 SSP 50200-04 *Note: Large Signal Stability and Stand-Alone Stability are defined in SSP 30482, Vol. 1.			

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs, EL-023 “Large Signal Stability” preliminary test data	1. L-20	1. Unique PVPs, EL-010 “Surge Current” analysis and test data	1. L-12
2. Unique PVPs, EL-011 “Reverse Energy/Current” analysis data	2. L-20	2. Unique PVPs, EL-011 “Reverse Energy/Current” updated analysis data	2. L-12 (if required)
3. Unique Payload Hardware ICDs, par. 3.2.5, “Source Impedance Limit” data	3. L-20	3. Unique PVPs, EL-014 “EPCE Load Impedance” test data	3. L-12
4. Unique Payload Hardware ICDs par. 3.2.7, “Surge Current” data	4. L-20	4. Unique PVPs, EL-015 “Maximum Ripple Voltage Emissions” analysis and test data	4. L-12
5. Unique PVPs, App. F “EMI/EMC Control, Test plan, and Design Analysis Report”	5. L-22	5. Unique PVPs, EL-016 “Load-Stand Alone Stability” analysis data	5. L-12
		6. Unique PVPs, EL-023 “Large Signal Stability” final test data	6. L-12
		7. Unique PVPs EL-020, “Electromagnetic Interference/Compatibility ” analysis, test, & inspection data	7. L-12
		8. Unique PVPs, EL-002, “Ripple Voltage Characteristics, Noise, and Spectrum”, Analysis & Test data	8. L-12
		9. Payload exceptions and waivers (if any)	9. L-12

Verification Number	Title	Verification Level	Method
EL-04	CHANNELIZED POWER/THERMAL ANALYSIS	Element & ISS	A

Verification Requirement:

The integrated ISS Modules and attached payloads shall be compatible with the available ISS electrical power and thermal resources for each defined ISS stage.

Detailed Description of Requirement:

Verify by analysis that the payload complement located in the pressurized module and attached payloads are compatible with the electrical and thermal resources available at the connected power channels or the thermal system loops at the interface locations. An electrical power systems analysis shall be performed using the reported payload complement electrical power requirements of:

a. keep-alive power
b. peak power
c. off-peak power
d. power to execute each integrated rack operating plan per the Unique PIA Addenda

The power available on each channel includes the effects of vehicle configuration, attitude, beta angle, electrical distribution system losses, and power sharing between DC-to-DC Converter Units (DDCUs) loads. Transient analysis shall be performed to determine operational constraints (turn-on/off combinations) based on integrated rack transient power characteristics. The vehicle heat rejection capability considers the vehicle configuration, attitude, and beta angle.

Verification Output:	Submittal Dates:
1. Preliminary element-level channelized power/thermal analysis summary addressing the constraints associated with the operation of a given integrated payload complement	1. L-15
2. Preliminary Channelized Power/Thermal ISS-level analysis summary addressing the constraints associated with the operation of a given integrated payload complement for a specified ISS stage	2. L-11
3. Final element-level channelized power/thermal analysis summary addressing the constraints associated with the operation of a given integrated payload complement	3. L-7
4. Final Channelized Power/Thermal ISS-level analysis summary addressing the constraints associated with the operation of a given integrated payload complement for a specified ISS stage	4. L-5

Applicable Document(s) and Notes:
Increment Definition Requirements Document (IDRD)
SSP 52000-PDS; Payload Data Set; par. 10.3.2.2 and 10.3.2.5
SSP 571##; Unique PIAs, Addenda Table 2.2.1-1
SSP 572##; Unique Payload Hardware ICDs
SSP 574##; Unique PVPs, FD-004, FD-005, & FD-008

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PIAs Addenda Table 2.2.1-1 (Pressurized Payload/Attached Payload-to-Element)	1. L-18	1. Unique PVPs, FD-004 “Coolant Flow Rate” analysis or test data (Pressurized Payload/Attached Payload-to-Element)	1. L-12
2. Unique Payload Hardware ICDs par. 3.5.1.3, “Coolant Flow Rate” and par. 3.5.1.9, “Cabin Air Heat Leak” data (Pressurized Payload/Attached Payload-to-Element)	2. L-20	2. Unique PVPs, FD-005 “Coolant Return Temperature” analysis and test data (Pressurized Payload/Attached Payload-to-Element)	2. L-12
3. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS)	3. L-15	3. Unique PVPs, FD-008 “Cabin Air Heat Leak” analysis data (Pressurized Payload/Attached Payload-to-Element)	3. L-12
		4. Payload Data Set, per 10.3.2.2 and 10.3.2.5 Activity Duration & Resources (Pressurized Payload/Attached Payload-to-Element)	4. L-12
		5. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS)	5. L-8
		6. Payload exceptions and waivers (if any)	6. L-12

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
CD-01	PAYLOAD MDM COMPLEMENT CONFIGURATION	Element	A&T

Verification Requirement:

The Payload Multiplexer/Demultiplexer (MDM) shall be configured to support the operational requirements of the on-orbit Payload Complement.

Detailed Description of Requirement:

Perform preliminary analysis of the on-orbit Payload Complement data to insure the Complement configuration tables, files, and data definitions do not exceed the P/L MDM memory constraints.

Use the PSIVF test environment and simulate the complement of Payloads; exercise the Payload MDM Flight Equivalent Unit with the Complement configuration of tables, files, and data definitions. Perform test to verify that the Payload MDM processing and memory constraints are not exceeded and that simultaneous operation of Payload does not create a compatibility problem for the executive software.

Note: Applies to ISS only if US data system extends to US payload located an IP element.

Verification Output:	Submittal Dates:
1. Preliminary Analysis and Test Summary	1. L-12
2. Intermediate Analysis and Test Summary	2. L-9
3. Final Analysis and Test Summary	3. L-6

Applicable Document(s) and Notes:

SSP 40200-04
SSP 52050
SSP 573##, Unique Payload Software ICDs, Tables A-1 through A-8, A-10, A-13 through A-17, B-1, and B-2

Preliminary Input Data Source:	Input Date:	Intermediate Input Data Source:	Input Date:
1. Unique Payload Software ICDs Tables A-1 through A-17, B-1, and B-2	1. L-16	1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2	1. L-11
		Final Input Data Source:	**Input Date:**
		1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2 (if required)	1. L-8
		2. Payload exceptions and waivers (if any)	2. L-12

Verification Number	Title	Verification Level	Method
CD-02	PAYLOAD MSD RESOURCE UTILIZATION	Element	A&T

Verification Requirement:

The Payload Multiplexer/Demultiplexer (MDM) and Mass Storage Device (MSD) shall be configured to support the operational requirements of the on-orbit Payload Complement.

Detailed Description of Requirement:

Perform preliminary analysis of the on-orbit Payload Complement data to insure the P/L MDM and MSD can support the operational requirements of the on-orbit Payload complement.

Load the on-orbit Payload Compliment flight configuration in the PSIV test environment and perform simulations of the critical utilization periods to verify the P/L MDM and MSD can support the on-orbit Payload Complement operational requirements.

Note: Applies to ISS only if US data system extends to US payload located an IP element.

Verification Output:	Submittal Dates:
1. Preliminary Analysis and Test Summary	1. L-12
2. Intermediate Analysis and Test Summary	2. L-9
3. Final Analysis and Test Summary	3. L-6

Applicable Document(s) and Notes:

D683-21413-1
SSP 573##; Unique Payload Software ICDs, Tables A-1 through A-8, A-10, A-13 through A-17, B-1, and B-2

Preliminary Input Data Source:	Input Date:	Intermediate Input Data Source:	Input Date:
1. Unique Payload Software ICDs Tables A-1 through A-17, B-1, and B-2	1. L-16	1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2	1. L-11
		Final Input Data Source:	Input Date:
		1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2 (if required)	1. L-8
		2. Payload exceptions and waivers (if any)	2. L-12

Verification Number	Title	Verification Level	Method
CD-03	TIMELINER CONFIGURATION AND UTILIZATION	Element	A&T

Verification Requirement:

Functions requiring automated procedures shall not exceed Timeliner executor or Payload Executive Software (PES) constraints.

Detailed Description of Requirement:

Perform analysis to ensure that the number of sequences and bundles of data required to support the on-orbit Payload Complement does not exceed the software capabilities of the Payload Timeliner Software Specifications.

Perform complement tests in the PSIVF test environment to ensure that the timeliner and PES configuration files support the execution of simultaneous complement Payload operations.

Note: Applies to ISS only if US data system extends to US payload located an IP element.

Verification Output:	Submittal Dates:
1. Preliminary Analysis and Test Summary	1. L-12
2. Intermediate Analysis and Test Summary	2. L-9
3. Final Analysis and Test Summary	3. L-6

Applicable Document(s) and Notes:

D683-21413-1
SSP 573##; Unique Payload Software ICDs, Tables A-1, A-5, A-7, A-8, A-10, A-13 through A-17

Preliminary Input Data Source:	Input Date:	Intermediate Input Data Source:	Input Date:
1. Unique Payload Software ICDs updated Tables A-1, A-5, A-7, A-8, A-10, and A-13 through A-17	1. L-16	1. Unique Payload Software ICDs updated Tables A-1, A-5, A-7, A-8, A-10, and A-13 through A-17	1. L-11
		Final Input Data Source:	Input Date:
		1. Unique Payload Software ICDs updated Tables A-1, A-5, A-7, A-8, A-10, and A-13 through A-17 (if required)	1. L-8
		2. Payload exceptions and waivers (if any)	2. L-12

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
CD-04	PCS PAYLOAD DISPLAYS AND APPLICATIONS SOFTWARE	Element	A&T

Verification Requirement:

The total complement of Payload displays and application software along with the system displays and software shall be compatible with PCS memory and processing speed margins.

Detailed Description of Requirement:

Perform preliminary analysis of the on-orbit Payload Complement data displays to insure the PCS System and Software Applications can support the on-orbit Payload Complement.

Test simulated complement configurations using the PSIVF to ensure that the PCS can operationally support the total complement of Payload displays and application software along with the system displays and software.

Note: Applies to ISS only if US data system extends to US payload located on an IP element.

Verification Output:	Submittal Dates:
1. Preliminary Analysis and Test Summary	1. L-12
2. Intermediate Analysis and Test Summary	2. L-9
3. Final Analysis and Test Summary	3. L-6

Applicable Document(s) and Notes:

D683-21413-1
JSC 27337, Portable Computer System
SSP 573##; Unique Payload Software ICDs, Tables A-1 through A-8, A-10, A-13 through A-17, B-1, and B-2

Preliminary Input Data Source:	Input Date:	Intermediate Input Data Source:	Input Date:
1. Unique Payload Software ICDs Tables A-1 through A-17, B-1, and B-2	1. L-16	1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2	1. L-11
		Final Input Source Data:	Input Date:
		1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2 (if required)	1. L-8
		2. Payload exceptions and waivers (if any)	2. L-12

<table>
<tr><td>Verification Number

CD-05</td><td colspan="3">Title

PAYLOAD 1553B AND ETHERNET DATA BUS LOADING</td><td>Verification Level

Element</td><td>Method

A&T</td></tr>
<tr><td colspan="6">Verification Requirement:

Operating Payload complement using the 1553B data bus and Ethernet LAN shall stay within bus allocations.</td></tr>
<tr><td colspan="6">Detailed Description of Requirement:

Verify by analysis that the Payload Complement 1553B Message Traffic, along with management and system traffic, does not exceed bus capacity/margins. Verify by test, using the PSIVF, that the configuration of remote terminals and payload complement operational requirements do not exceed the operational capacity of each Payload Multiplexer/Demultiplexer 1553B Local Bus. Verify by analysis and test that the Payload Complement Ethernet LAN traffic does not exceed bus capacity and operational constraints.

Note: Applies to ISS only if US data system extends to US payload located on an IP element.</td></tr>
<tr><td colspan="5">Verification Output:

1. Preliminary Analysis and Test Summary

2. Intermediate Analysis and Test Summary

3. Final Analysis and Test Summary (first time only)</td><td>Submittal Dates:

1. L-12

2. L-9

3. L-6</td></tr>
<tr><td colspan="6">Applicable Document(s) and Notes:

D683-21413-1
D684-10500-03
MIL-HBK-1553 App. A
MIL-STD-1553
ISO/IEC 8802.3
SSP 52050
SSP 573##; Unique Payload Software ICDs, Tables A-1 through A-8, A-10, A-13 through A-17, B-1, and B-2</td></tr>
<tr><td>Preliminary Input Data Source:

1. Unique Payload Software ICDs Tables A-1 through A-17, B-1, and B-2</td><td>Input Date:

1. L-16</td><td colspan="3">Intermediate Input Data Source:

1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2

Final Input Data Source:

1. Unique Payload Software ICDs updated Tables A-1 through A-17, B-1, and B-2

2. Payload exceptions and waivers (if any)</td><td>Input Date:

1. L-11

Input Date:

1. L-8

2. L-12</td></tr>
</table>

<table>
<tr><td>Verification Number

CD-06</td><td colspan="3">Title

PAYLOAD DATA LINK AND SOFTWARE SERVICE ASSESSMENT</td><td>Verification Level

Element</td><td>Method

A</td></tr>
<tr><td colspan="6">Verification Requirement:

The Payload complement operations shall be compatible with the capabilities and constraints of the ISS LRDL, MRDL, HRDL and Software Services to ensure that Low Rate Telemetry, Health and Status, and command uplinks do not exceed capabilities.</td></tr>
<tr><td colspan="6">Detailed Description of Requirement:

Perform analysis of the on-orbit Payload Complement LRDL and MRDL to ensure that the message traffic does not exceed the LAN capabilities, and of HRDL to ensure that packet size and rate restrictions are met.

The analysis should address:

• peak and off-peak data flow.
• aggregate payload data traffic from payload to payload. (MRDL, HRDL only)
• aggregate payload data traffic from payloads to downlink.

Note: Applies to ISS only if US data system extends to US payload located on an IP element.</td></tr>
<tr><td colspan="4">Verification Output:

1. Preliminary Analysis Summary

2. Final Analysis Summary</td><td colspan="2">Submittal Dates:

1. L-16

2. L-8</td></tr>
<tr><td colspan="6">Applicable Document(s) and Notes:

D683-21413-1
SSP 52000-PIA-PRP
SSP 57###, Unique Payload Software ICD</td></tr>
<tr><td>Preliminary Input Data Source:

1. PIA Addenda Tables 2.1.1-1, 2.1.2-1, and 2.2.1-1

2. Unique Payload Software ICDs</td><td>Input Date:

1. L-18

2. L-16</td><td colspan="2">Final Input Data Source:

1. PIA Addenda Tables 2.1.1-1, 2.1.2-1, and 2.2.1-1 (if required)

2. Unique Payload Software ICDs (Update)</td><td colspan="2">Input Date:

1. L-12

2. L-11</td></tr>
</table>

Verification Number	Title	Verification Level	Method
FD-01	INTEGRATED TRUSS ELEMENT THERMAL COMPATIBILITY	Element	A

Verification Requirement:

Integrated Truss attached payloads will be analyzed to ensure that the Payload Complement is compatible with external thermal environment.

Detailed Description of Requirement:

TBD-19

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Final element-level analysis summary	2. L-7

Applicable Document(s) and Notes:

TBD-19

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
TBD-19	1. L-20	TBD-19	1. L-12

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
FD-02	FLUID AND ATMOSPHERE CONSUMABLES USAGE	Element & ISS	A

Verification Requirement:

Fluid consumables used by the Element Payload Complement shall be compatible with the consumables available within the Pressurized Module. Gas leakage will be measured when the payload is connected to pressurized nitrogen, to ensure leakage is less than the allowable limit.

Detailed Description of Requirement:

Perform a Payload Complement Analysis of the fluid consumables usage and gas leakage. The analysis will assess the integrated Payload requirements against the available fluids to ensure sufficient availability of consumables. The analysis will be used to show that the sum of all the potential leakage sources in the integrated rack do not exceed the allowable leakage at the MDP.

Verification Output:	Submittal Dates:
1. Preliminary element-level fluid consumption and gas leakage (N_2) analysis summary for the NASDA JEM	1. L-15
2. Preliminary ISS-level fluid consumption and gas leakage (N_2) analysis summary addressing: • Nitrogen • Water • Atmospheric Oxygen • Atmosphere Usage	2. L-11
3. Final element-level fluid consumption and leakage analysis summary for the NASDA JEM only addressing: • Argon • Helium • Carbon Dioxide	3. L-7
4. Final element-level gas consumption and leakage (N_2) analysis for the NASDA JEM	4. L-7
5. Final ISS-level fluid consumption and gas leakage analysis summary	5. L-5

Applicable Document(s) and Notes:
SSP 50200-04
SSP 571##; Unique Payload PIAs, Addenda Table 2.2.1-1
SSP 572##; Unique Payload Hardware ICDs, par. 3.9.2
SSP 574##; Unique PVPs, FD-027, FD-030 and EN-003

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique Payload Hardware ICDs, par. 3.9.2, "Active Heat Exchange" data (Pressurized Payload-to-Element)	1. L-20	1. Unique Payload PVPs, FD-030 "Potable Water" updated analysis data (Pressurized Payload-to-Element)	1. L-12
2. Unique PVPs, FD-030 "Potable Water" analysis data (Pressurized Payload-to-Element)	2. L-20	2. Unique Payload PVPs, EN-003 "Oxygen Consumption" analysis data (Pressurized Payload-to-Element)	2. L-12
3. Unique Payload PIAs Addenda, Table 2.2.1-1 data (Pressurized Payload-to-Element)	3. L-18	3. Unique Payload PIAs Addenda, Table 2.2.1-1 update (Pressurized Payload-to-Element)	3. L-12 if required.
4. Unique PVPs, EN-003 "Oxygen Consumption" analysis data (Pressurized Payload-to-Element)	4. L-20	4. Unique Payload PVPs, FD-027 "Pressurized Gases Leakage" test data (Pressurized Payload-to-Element)	4. L-12
5. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS)	5. L-15	5. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS)	5. L-8
		6. Payload exceptions and waivers (if any)	6. L-12

Verification Number	Title	Verification Level	Method
FD-03	CO_2 PARTIAL PRESSURE	Element & ISS	A

Verification Requirement:

The ISS Payload complement shall be compatible with the limits on CO_2 partial pressure.

Detailed Description of Requirement:

Perform an analysis of the CO_2 partial pressure, under expected operating conditions, to determine if operation of the second CO_2 removal assembly is required to meet the science requirements (lowest and highest CO_2 limit), which would affect the power and thermal analyses.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Preliminary ISS-level analysis summary	2. L-11
3. Final element-level analysis summary	3. L-7
4. Final ISS-level analysis summary	4. L-5

Applicable Document(s) and Notes:

SSP 50200-4
SSP 571##; Unique Payload PIAs, Addenda Table TBD-20
SSP 574##; Unique PVPs, EN-003

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PIAs Addenda Table TBD-20 (Pressurized Payload/Attached Payload-to-Element) (This data will be provided until ECLSS is fully implemented after Node 3 assembly.)	1. L-20	1. Unique PIAs Addenda Table TBD-20 update (Pressurized Payload/Attached Payload-to-Element)	1. L-12 if required
		2. Unique PVPs EN-003, “Oxygen Consumption”, analysis data (Pressurized Payload/Attached Payload-to-Element)	2. L-12
2. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS) TBD-18	2. L-15	3. IP inputs (including payload operations guidelines and constraints), (Element-to-ISS) TBD-18	3. L-11
		4. Payload exceptions and waivers (if any)	4. L-12

Verification Number	Title	Verification Level	Method
FD-04	VES ACCEPTABLE EXHAUST GASES	Element	A

Verification Requirement:

Verify exhaust gases are compatible with VES wetted materials.

Detailed Description of Requirement:

Perform analysis on VES exhaust gases to ensure compatibility with VES wetted materials.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Final element-level analysis summary: • Certificate of Compliance from ISS Materials Working Group	2. L-7

Applicable Document(s) and Notes:

SSP 41002, section 3.3.7.2
SSP 574##; Unique PVPs, FD-018
SSP 572##; Unique Payload Hardware ICDs, Table 3.6.1.1-1

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs, FD-018 “VES Acceptable Exhaust Gases”	1. L-20	1. Unique PVPs, FD-018 “VES Acceptable Exhaust Gases”	1. L-12
2. Unique Payload Hardware ICDs, Table 3.6.1.1-1 data	2. L-20	2. Payload exceptions and waivers (if any)	2. L-12

Verification Number	Title	Verification Level	Method
FD-05	LATENT HEAT LOAD	Element	A

Verification Requirement:

Verify that the payload complement does not exceed the module limit.

Detailed Description of Requirement:

Perform a Payload operating complement analysis of Payload generated latent heat to determine if the latent heat loads exceed allowable module limits.

NOTE: Add to total heat leak/cooling from FD-07, “Pressurized Element Thermal Compatibility”, if required.

Verification Output:	Submittal Dates:
1. Preliminary element-level analysis summary	1. L-15
2. Final element-level analysis summary	2. L-7

Applicable Document(s) and Notes:

SSP 41002
SSP 52000-PDS; Payload Data Set; par. 10.3.2.2 and 10.3.2.5
SSP 572##; Unique Payload Hardware ICDs, par. 3.5.1.8-2
SSP 571##; Unique PIAs, Addenda Table 2.2.1-1
SSP 574##, Unique PVPs, FD-008

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique Payload Hardware ICDs, par. 3.5.1.8-2	1. L-20	1. Unique Payload Hardware ICDs, par. 3.5.1.8-2 update	1. L-12 if required
2. Unique Payload PIAs Addenda, Table 2.2.1-1	2. L-18	2. Unique Payload PIAs Addenda, Table 2.2.1-1 update	2. L-12 if required
		3. Payload Data Set, per 10.3.2.2 and 10.3.2.5, Activity Duration & Resources	3. L-12
		4. Unique PVPs, FD-008 “Cabin Air Heat Leak”, analysis data	4. L-12
		5. Payload exceptions and waivers (if any)	5. L-12

Verification Number	Title	Verification Level	Method
FD-06	EXTERNAL CONTAMINATION/VENTING	Element & ISS	A

Verification Requirement:

Materials released from the pressurized module and from attached payloads due to outgassing and venting shall be in accordance with SSP 30426.

Detailed Description of Requirement:

Verify by analysis that the venting of pressurized payload vented gases including trace components and attached payloads materials outgassing and venting complies with the external contamination control requirements defined in SSP 30426 (covering molecular deposition, molecular column density, and particulate generation).

Verification Output:	Submittal Dates:
1. Preliminary element-level Pressurized Payload Gas Venting and Attached Payloads outgassing and venting analysis summary	1. L-15
2. Preliminary ISS-Level Pressurized Payload Gas Venting and Attached Payload outgassing and venting analysis summary	2. L-11
3. Final element-level Pressurized Payload exhaust Gas Venting and Attached Payloads outgassing and venting analysis summary (if required)	3. L-7
4. Final ISS-Level Pressurized Payload Gas Venting and Attached Payloads outgassing and venting analysis summary (if required)	4. L-5

Applicable Document(s) and Notes:

NSTS 1700.7; par.209.1
NSTS 1700.7 ISS Addendum; par. 209.1
SSP 30426, External Contamination Requirements, par. 3.4.1, 3.4.2, 3.4.3, and 3.5 (if applicable)
SSP 57020; Pressurized Payload Accommodations Handbook
SSP 571##; Unique PIAs, Addenda Table 2.2.1-1
SSP 574##; Unique PVPs, FD-019
SSP 572##; Unique Payload Hardware ICDs, Table 3.6.1.1-1 and 3.6.2.1-1

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique PVPs, FD-019 “External Contamination Control” Data Cert. (Pressurized Payload/Attached Payload-to-Element)	1. L-20	1. Unique PVPs, FD-019 “External Contamination Control” analysis data (Pressurized Payload/Attached Payload-to-Element)	1. L-12
2. Unique Payload PIAs Addenda, Table 2.2.1-1 (Pressurized Payload/Attached Payload-to-Element)	2. L-18	2. Unique Payload PIAs Addenda, Table 2.2.1-1 (Pressurized Payload/Attached Payload-to-Element)	2. L-12 (if required)
3. Unique Payload Hardware ICDs, Tables 3.6.1.1-1, “VES Acceptable Exhaust Gas”, and 3.6.2.1-1, “VRS Acceptable Exhaust Gas”, data (Pressurized Payload/Attached Payload-to-Element)	3. L-20	3. IP inputs (Element-to-ISS) - PIA Addenda (Pressurized/Attached) - Unique PVPs (Pressurized/Attached) - Hardware ICDs (Pressurized only) - Payload operations guidelines and constraints	3. L-8
4. IP inputs (Element-to-ISS) - PIA Addenda (Pressurized/Attached) - Unique PVPs (Pressurized/Attached) - Hardware ICDs (Pressurized only) - Payload operations guidelines and constraints	4. L-15	4. Payload exceptions and waivers (if any)	4. L-12

COMPATIBILITY VERIFICATION DEFINITION SHEETS

Verification Number	Title	Verification Level	Method
FD-07	PRESSURIZED ELEMENT THERMAL COMPATIBILITY	Element	A

Verification Requirement:

Each Lab Complement of Payloads shall be analyzed to ensure compatibility with the available TCS resources for each defined ISS stage.

Detailed Description of Requirement:

Perform an integrated payload thermal analysis of the pressurized element TCS. Payload thermal interfaces to be analyzed include:

- Rack-to-cabin air heat leak/cooling.
- Coolant fluid leakage.
- Rack coolant flow rates vs. module capability.
- Heat rejection to water loop (output to EL-04)
- Coolant Quantity

Verification Output:	Submittal Dates:
1. Preliminary Element-Level analysis summary (excluding coolant fluid leakage)	1. L-15
2. Final Element-Level analysis summary	2. L-7

Applicable Document(s) and Notes:
SSP 41002
SSP 52000-PDS; Payload Data Set; par. 10.3.2.2 and 10.3.2.5
SSP 571##; Unique PIAs, Addenda Table 2.2.1-1
SSP 572##; Unique Payload Hardware ICDs, par. 3.5.1-2, 3.5.1-3, 3.5.1-9, and 3.5.1-10
SSP 574##; Unique PVPs, FD-003, FD-004, FD-005, FD-006, FD-008, and FD-009

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique Payload PIAs Addenda, Table 2.2.1-1 data	1. L-18	1. Unique PVPs, FD-003 “ITCS Pressure Drop” data	1. L-12
2. Unique Payload Hardware ICDs, par. 3.5.1-3 “Coolant Flow Rate and Pressure Drop” data	2. L-20	2. Unique PVPs, FD-004 “Coolant Flow Rate” data	2. L-12
3. Unique Payload Hardware ICDs, par. 3.5.1-9 “Cabin Air Heat Leak” data	3. L-20	3. Unique PVPs, FD-005 “Coolant Return Temperature” data	3. L-12
4. Unique Payload Hardware ICDs, par. 3.5.1-10 “Cabin Air Cooling” data	4. L-20	4. Unique PVPs, FD-006 “Coolant Loop Leakage” data	4. L-12
		5. Unique PVPs, FD-008 “Cabin Air Heat Leak” data	5. L-12
		6. Unique PVPs, FD-009 “MPLM_Cabin Air Cooling” data	6. L-12
		7. Unique PVPs, FD-012 “Payload Coolant Quantity” data.	7. L-12
		8. PL Data Set per 10.3.2.2 and 10.3.2.5, Activity Duration and Response	8. L-12
		9. Payload exceptions and waivers (if any)	9. L-12

<table>
<tr><td>Verification Number
EN-01</td><td>Title
MICROGRAVITY</td><td>Verification Level
Element & ISS</td><td>Method
A</td></tr>
<tr><td colspan="4">Verification Requirement:
Provide an acceptable microgravity environment for payload complement within the limits specified in SSP 41000, paragraph 3.2.1.1.4.1 and the disturbances allocation per SSP 57000, Section 3.1.2.</td></tr>
<tr><td colspan="4">Detailed Description of Requirement:
Verify that the integrated complement of payloads meet the microgravity quasi-steady, transient, and vibratory requirements specified in SSP 57000. The integrated microgravity assessment for payloads shall be accomplished by analysis of payload data submitted to show compliance with SSP 57000 and the Unique Hardware ICD. Non-compliant data may require additional integrated ISS-level transfer function analysis. If required, and payload to payload unique transfer functions are not available, these will be generated by the Vehicle using NASA Structural Analysis Computer Program (NASTRAN) and Statistical Energy Analysis (SEA). If required for quasi-steady analysis, the vehicle may use Space Station Multi-Rigid Body Simulation (SSMRBS) Program.</td></tr>
<tr><td colspan="3">Verification Output: (Integrated microgravity structural analysis (FEM and SEA) is to be performed for Stage UF-1, Stage UF-3, and Assembly Complete only)
1. Preliminary Microgravity Element-Level and ISS-Level Analysis Summary addressing:
• Matrix showing payloads vs. microgravity requirement indicating potential problems
• Identification of needed location-specific Vehicle Team transfer functions
2. Final Microgravity Element-Level and ISS-Level Analysis Summary addressing:
• Updated Matrix identified above
• Vehicle Team's refined transfer functions and coupled payload analysis results</td><td>Submittal Dates:
1. L-15 for the Element-Level
L-11 for the ISS-Level
2. L-7 for the Element-Level
L-5 for the ISS-Level</td></tr>
<tr><td colspan="4">Applicable Document(s) and Notes:
ISS System Verification Data
SSP 41000, par. 3.2.1.1.4.1
SSP 57000; par. 3.1.2
SSP 571##; Unique PIAs, Addenda Table 1.2.4-1 and Table 2.2.1-1
SSP 572##; Unique Payload Hardware ICDs, Sec. 3.1.2
SSP 574##; Unique PVPs, EN-005
Simplified Element-To-ISS FEM Models for IPs (obtained through BDEALs)
Simplified Rack-To-ISS FEM Models for Element (obtained through BDEALs)</td></tr>
<tr><td colspan="4">Continued on next page.</td></tr>
</table>

Verification Number EN-01	Title MICROGRAVITY	Verification Level Element & ISS	Method A

Continued from previous page.

Preliminary Input Data Source:	Input Date:	Final Input Data Source:	Input Date:
1. Unique Payloads Microgravity Control Plans (Pressurized Payload/Attached Payload-to-Element)	1. L-22	1. Unique PVPs EN-005, “Microgravity Environment”, final data (Pressurized Payload/Attached Payload-to-Element).	1. L-12
2. Unique Payload HDW ICDs Sec. 3.1.2 data (Pressurized Payload/Attached Payload-to-Element)	2. L-20	2. Payload FEM or SEA (Pressurized Payload/Attached Payload-to-Element) (if required)	2. L-12
3. Unique Payload PIAs Addenda, Table 1.2.4-1 and Table 2.2.1-1. (Pressurized Payload/Attached Payload-to-Element)	3. L-18	3. IP inputs (Element-To-ISS) a) Pressurized Module - Source force, rack interface force, internal ARIS rack PL force, and acceleration levels vs. frequency. Data is to be provided in one-third octave or narrow band tab separated ASCII field format b) Attached sites – TBD-18 c) Payload operations guidelines and constraints	3. L-8
4. Payload FEM or SEA Models (Pressurized Payload/Attached Payload-to-Element)	4. L-20	4. Payload exceptions and waivers (if any)	4. L-12
5. IP inputs (Element-To-ISS) a) Pressurized Module – Source force, rack interface force, internal ARIS rack PL force, and acceleration levels vs. frequency. Data is to be provided in one-third octave or narrow band tab separated ASCII field format b) Attached sites – TBD-18 c) Payload operations guidelines and constraints	5. L-15		

<table>
<tr><td>Verification Number
EN-02</td><td colspan="3">Title
ACOUSTIC EMISSIONS</td><td>Verification Level
Element</td><td>Method
A</td></tr>
<tr><td colspan="6">Verification Requirement:
Verify that the acoustic emissions from the payload complement do not exceed NC-48 requirements and the subsystems of the pressurized module do not exceed NC-50 requirements in pressurized modules.</td></tr>
<tr><td colspan="6">Detailed Description of Requirement:
(I) Payload Complement
Verify by analysis that the composite sound levels for the complement of pressurized payloads does not exceed NC-48 requirements in each module. Perform acoustical analyses to support Payload Operations Integration Center (POIC) in developing payload timelines so that the payload complement acoustical noise limit is achieved. The amount and type of data which needs to be provided by the Payload Developer is dependent upon whether the rack will have sub-rack payloads which will change out during its stay on the ISS, and whether the results of their acoustic noise levels satisfy the requirements specified in the acoustic section of SSP 57000.
Case A: Integrated rack does not have sub-rack payloads which change, and meets NC-40 sound pressure noise requirement.
Information Required: Sound pressure level testing conducted for all sides of the rack; Test Report.
Case B: Integrated rack does not have sub-rack payloads which change, and does not meet NC-40 sound pressure noise requirement.
Information Required: Sound power measurements for all sides of the rack; Test Report.
Case C: Integrated rack does have sub-rack payloads which change, and meets NC-40 sound pressure noise requirement.
Information Required: Analysis proving that a change out of a sub-rack payload translates into producing accurate rack level sound pressure data; Analysis Report including the test data showing sound pressure prediction for the rack.
Case D: Integrated rack does have sub-rack payloads which change, and does not meet NC-40 sound pressure noise requirement.
Information Required: Analysis proving that a change out of a sub-rack payload translates into producing accurate rack level sound pressure data; Analysis Report including the test data showing sound power of the continuous noise level for the rack.

(II) Pressurized Module Subsystems
Verify by test that the composite sound levels for all the subsystems of the pressurized module does not exceed the NC-50 requirement specified in section 3.3.10.2 of SSP 41000.

Note: If the payload complement or the subsystems of the pressurized module exceed their requirements, the payload complement and the subsystems acoustic emissions will be required to be combined to determine the overall integrated module noise levels.</td></tr>
<tr><td colspan="5">Verification Output:
1. Preliminary acoustic element-level analysis summary
2. Final acoustic element-level analysis summary</td><td>Submittal Dates:
1. L-15
2. L-7</td></tr>
<tr><td colspan="6">Applicable Document(s) and Notes:
ISS System Verification Data
SSP 41000, Rev. B; par. 3.3.10.2
SSP 572##; Unique Payload Hardware ICDs, Sec. 3.9.2.1-1, 3.9.2.2-1
SSP 574##; Unique PVPs, EN-006</td></tr>
<tr><td>Preliminary Input Data Source:
1. Unique Payload Hardware ICDs, Sec. 3.9.2.1-1 and 3.9.2.2-1 data
2. Unique PVPs EN-006, “Acoustic Noise Control Plan”</td><td>Input Date:
1. L-20
2. L-26</td><td colspan="2">Final Input Data Source:
1. Unique PVPs EN-006, “Acoustic Levels” update
2. Payload exceptions and waivers (if any)</td><td colspan="2">Input Date:
1. L-12 if required
2. L-12</td></tr>
</table>

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OPEN ISSUES

D.1 TO BE DETERMINED ITEMS

TABLE D.1-1 TO BE DETERMINED ITEMS

TBD No.	Description	Document Section	Page No.	Responsible
4	The number for the document that defines the unique interfaces of the JEM-EF needs to be provided.	3.4.9.2	3-8	NASDA
6	The number for the ROSAVIACOSMOS Generic Verification Plan needs to be provided	3.5.1	3-27	ROSAVIACOSMOS
7	The number for the JEM-EF Generic Verification Plan needs to be provided	3.5.1	3-27	NASDA
8	The number for the document that defines the JEM-EF checkout/installation procedures needs to be provided.	3.5.4	3-30	NASDA
11	CVDS ME-03 needs to be completed and it's applicability to the ISS-level analysis needs to be identified on Table C.2.1-1.	Table C.2.1-1 CVDS ME-03	C-5 C-9	NASA
12	CVDS ME-04 needs to be completed and it's applicability to the ISS-level analysis needs to be identified on Table C.2.1-1.	Table C.2.1-1 CVDS ME-04	C-5 C-10	NASA
14	CVDS ME-08 needs to be completed and it's applicability to the attached element-level analysis needs to be identified on Table C.2.1-1.	Table C.2.1-1 CVDS ME-08	C-5 C-14	NASA
16	CVDS ME-10 needs to be completed and it's applicability to the attached element-level and ISS-level analyses needs to be identified on Table C.2.1-1.	Table C.2.1-1 CVDS ME-08	C-5 C-16	NASA
18	International Partner inputs need to be identified on CVDSs ME-03, ME-04, ME-10, FD-03, EN-01	CVDS ME-03 CVDS ME-04 CVDS ME-10 CVDS FD-03 CVDS EN-01	C-9 C-10 C-16 C-29 C-35	ESA NASDA ROSAVIACOSMOS
19	CVDS FD-01 needs to be completed and it's applicability to the attached element-level analysis needs to be identified on Table C.2.1-1.	Table C.2.1-1 CVDS FD-01	C-5 C-27	NASA
20	Unique PIA Addenda Table containing CO2 Partial Pressure data needs to be identified.	CVDS FD-03	C-29	NASA
21	The attached element-level thermal analysis process flow needs to be provided.	Fig. 3.4.11-5	3-15	NASA

TABLE D.1-1 TO BE DETERMINED ITEMS (continued)

TBD No.	Description	Document Section	Page No.	Responsible
22	The element-level and ISS-level attached payload related analysis process flows need to be provided.	Fig. 3.4.11-15	3-25	NASA
23	The facility that will be used to verify NASDA payloads manifested for JEM, prior to operation, needs to be identified.	3.6	3-31	NASDA
24	The applicability of FD-06 to the attached element-level analysis needs to be identified in Table C.2.1-1	Table C.2.1-1	C-6	NASA

D.1 TO BE RESOLVED ITEMS

TABLE D.1-1 TO BE RESOLVED ITEMS

TBR No.	Description	Document Section	Page No.	Responsible
1	There is a concern from ESA regarding the SSP 57000 IRD being the sole source requirements document for all payloads and for all partner element requirements. This issue needs to be worked between agencies and resolved by updating SPIP Vol. 4, Section 3.2.2.2.	3.4.9.3	C-9	NASA ESA NASDA ROSAVIACOSMOS